TIME DOMAIN ELECTROMAGNETIC SURVEYS FOR ASSISTING IN DETERMINING THE GROUNDWATER RESOURCES ON THE ISLAND OF LANAI, HAWAII

Blackhawk GeoSciences Project Number 2144LWC

Prepared For:

LANAI WATER COMPANY, INC.

TIME DOMAIN ELECTROMAGNETIC SURVEYS FOR ASSISTING IN DETERMINING THE GROUNDWATER RESOURCES ON THE ISLAND OF LANAI, HAWAII

BLACKHAWK GEOSCIENCES PROJECT NUMBER 2144LWC

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September 12, 2001

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1.0 EXECUTIVE SUMMARY

Time Domain Electromagnetic (TDEM) surveys were performed by Blackhawk GeoSciences for the Lanai Water Company in August 2001. The objective of the TDEM surveys is to add additional detail to previous TDEM interpretations, and to explore for anomalous basal groundwater occurrences. The previous TDEM surveys conducted by Blackhawk are summarized in Blackhawk project report number 9081-000, dated December 15, 1994.

In this (present) TDEM survey, seven areas were surveyed. The specific objectives of the present surveys were:

- To refine the location of the interpreted groundwater damming structure at selected locations (Areas 1 and 2), and
- To explore for anomalous basal groundwater occurrences (Areas 3-7).

The TDEM surveys in Area 1 resulted in repositioning of the interpreted groundwater structure approximately 800 to 1,000 feet further west (seaward) than previously interpreted. This new position reduces the available basal groundwater resource in this Area.

The TDEM surveys conducted in Area 2 show that the position of the main groundwater damming structure is unchanged; however a geologic structure (interpreted as a rift zone) was interpreted in Maunalei Gulch. Groundwater wells in the vicinity of these structures have historically been poor.

The results of the exploration for anomalous basal groundwater occurrences in Areas 3-7 indicate that Areas 4 and 6 may have better than normal basal groundwater resources compared to other basal mode occurrences on Lanai. To date, most wells drilled for basal mode groundwater occurrences on Lanai have been poor. This interpretation is based on the relative depth of the saltwater intrusion over a limited area at the sites. At both sites the depth to saltwater intruded formations is deeper than expected, inferring a thicker brackish/fresh water resource. Other factors, such as a decrease of permeability of the formation, or existence of altered volcanics may contribute to this increase in depth of the saltwater intruded formations. Both of these conditions would result in low production wells.

The results from this survey do not indicate that the existence of anomalous basal groundwater resources. The present survey supports the conclusions derived from previous surveys, i.e.:

- Basal groundwater is present around the perimeter of the Island, but the fresh/brackish water lens is limited. The thickness of fresh/brackish water above sea level is expected to be a minimal resource.
- A geologic/hydrologic discontinuity interpreted as a ground water damming structure is present around the entire Island. The potential for significant high-level ground water is present throughout the central portion of the entire Island. Well data has substantiated this interpretation.

2.0 INTRODUCTION

This report contains the results of surface Time Domain Electromagnetic (TDEM) geophysical surveys performed on the Island of Lanai for Lanai Water Company. The surveys were conducted by Blackhawk GeoSciences from August 13 to August 19, 2001. Blackhawk has conducted several previous TDEM surveys on Lanai. The results of these surveys are summarized in Blackhawk project report number 9081-000, dated December 15, 1994.

TDEM is a geophysical method that determines from the surface the geoelectric section (resistivity layering) of the subsurface. From the geoelectric section, information about geology and water quality can be inferred, because the electrical resistivity of the earth depends on lithology, porosity, and concentration of dissolved solids in the ground water.

The general objectives of the measurements on Lanai were to further refine the interpreted location of groundwater damming structures, and explore for possible anomalous basal groundwater occurrences (i.e. springs, relative thick basal layers). TDEM surveys were conducted in seven areas on the Island. The locations and objectives in each area are given in Table 2.1 below.

Table 2.1

Survey Locations and Objectives. TDEM Surveys on Lanai.

Date	TDEM Study Area	Survey Site Description	Objective
August 13-15	Area 1	North of Airport (EM37)	Further define the location of interpreted groundwater damming structures.
August 15-16	Area 2	Maunalei Gulch (EM37 and EM47)	Further define the location of interpreted groundwater damming structures.
August 17	Area 3	Maunalei Gulch-Detailed (EM47) Work.	Explore for anomalous groundwater occurrences in basal mode.
August 17	Area 4	Club Lanai/Kahea Gulch-Detailed (EM47) Work	Explore for anomalous groundwater occurrences in basal mode.
August 18	Area 5	Haua Gulch-Detailed (EM47) Work	Explore for anomalous groundwater occurrences in basal mode.
August 18	Area 6	Hauola Gulch-Detailed (EM47) Work	Explore for anomalous groundwater occurrences in basal mode.
August 19	Area 7	Unnamed Gulch East of Manele Road-Detailed (EM47) Work	Explore for anomalous groundwater occurrences in basal mode.

The survey areas and objectives in each survey area were determined during a meeting with senior staff and consultants of the Lanai Company on August 13, 2001 at the Lanai Company offices in Lanai City. A location map showing the positions of the TDEM Study Areas and the locations of TDEM soundings taken in previous surveys is given on Figure 2-1. This figure also shows the main findings of the previous TDEM surveys, i.e.:

- Basal groundwater is present around the perimeter of the Island, but the fresh/brackish water lens is limited. The thickness of fresh/brackish water above sea level was calculated to be a minimal resource.
- A geologic/hydrologic discontinuity interpreted as a ground water damming structure is present around the entire Island.
- The potential for high-level ground water is present throughout the central portion of the entire Island. Well data has substantiated this interpretation.

3.0 GEOLOGY/HYDROGEOLOGY

The geologic and hydrologic framework of Lanai is described fully in the previous geophysical report (Blackhawk Project Report 9081-000). A brief review of this framework follows.

Groundwater resources occur in the Hawaiian Islands basically in two modes:

- In a basal mode where a lens of fresh water floats on saline water, and
- In a high-level mode where the groundwater occurrence is controlled by damming structures.

These two modes of ground water occurrences are illustrated in Figure 3-1. Groundwater may also occur in areas between these two modes, but production is expected to highly variable. The area between these two modes is termed the "damming structure". TDEM surveys previously run on Lanai and other Hawaiian Islands have reliably mapped the damming structure, and normally, this structure parallels the coastline in a volcanic setting. The previous TDEM surveys on Lanai have shown that other secondary damming structure exist above the main damming structure (i.e. Palawai Basin). Figure 3-2 shows a schematic geologic model that can help explain these two types of damming structures. Outlined in the figure is a major ring fracture developed from a caldera, which is shown to occur inland and near parallel to the shoreline. Also shown are radial fractures which are thought to form near perpendicular to the major caldera ring fracture. Not shown are subsequent minor ring fractures which are postulated to occur within the major ring fracture. It is also postulated that the fracture areas are zones of weakness where intrusive dikes may preferentially form and these dikes can be impermeable. The radial fractures could be numerous and they could divide the high-level water into different compartments behind the major ring fractures. The resultant water production from a single compartment will be determined by several important factors which include permeability, porosity, size of and recharge to the compartment.

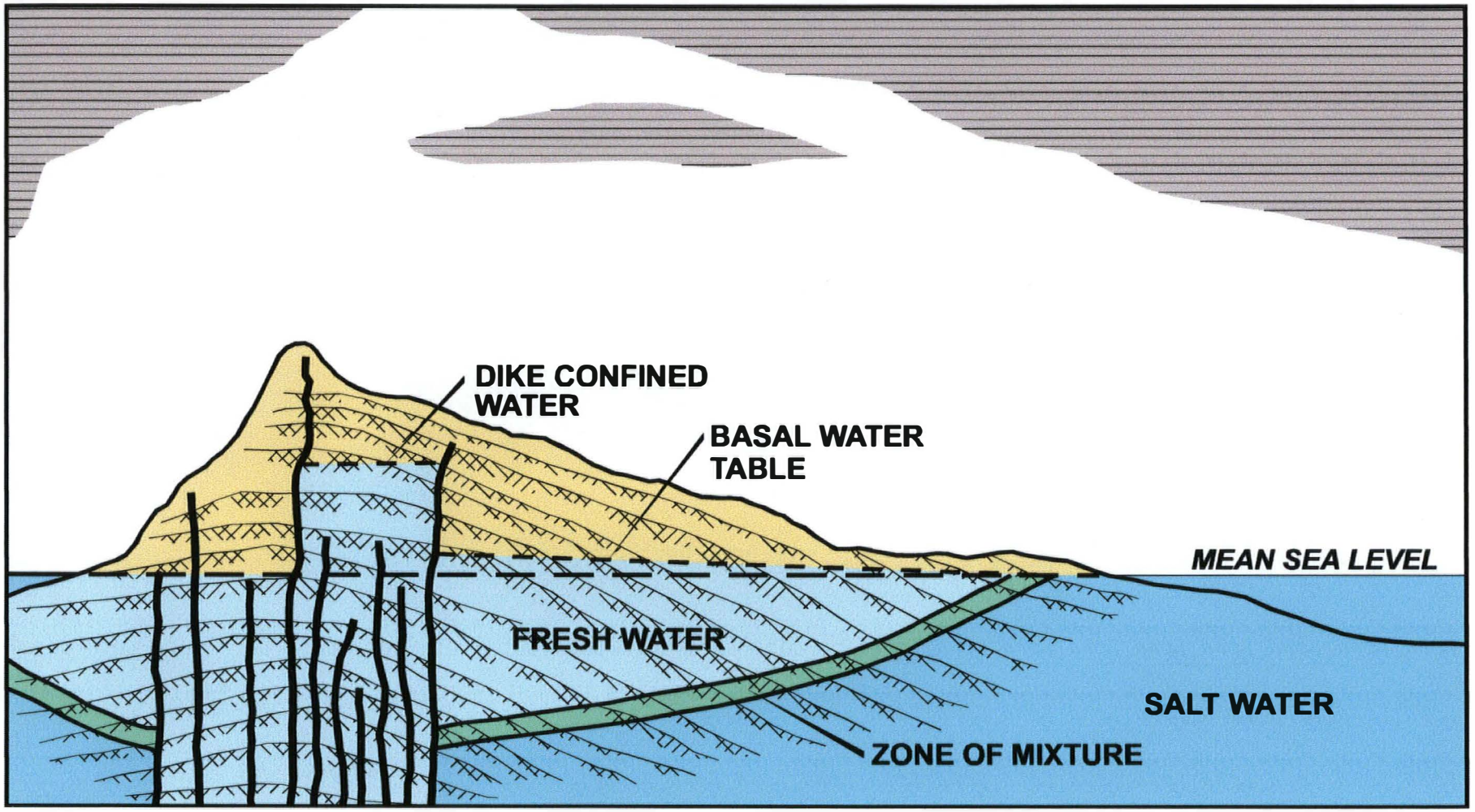
Basal mode groundwater is resting nearly at sea level near the ocean surrounding the Island of Lanai. This is mainly due to the fact that the volcanic rocks which comprise the Island allow rainfall to percolate with little impedance directly downward through the island mass (reference Figure 3-1). The fresh water is assumed to float upon the seawater encroaching from the ocean. Fresh water flows laterally toward the ocean causing the fresh water lens to be thinner towards the ocean. When groundwater is under conditions of static equilibrium, the Ghyben-Herzberg Principle states that for every one foot of fresh water above sea level, approximately 40 feet of fresh water will exist below sea level. While at static equilibrium, the transition from fresh water to seawater is generally quite sharp.

TDEM surveys map the resistivity stratification of the subsurface. From numerous previous surveys and calibration at well sites, characteristic ranges of subsurface resistivities have been derived for the geologic/hydrologic units shown in Figure 3-3. Some overlap in resistivities occurs between different units, however other factors (such as elevation) can be used to separate the units. Thus the main geologic/hydrologic units that can be derived from TDEM surveys are:

- Depth to seawater saturated volcanics. This occurs in basal mode occurrences, and by using the Ghyben-Herzberg Principle, the thickness of the basal fresh water lens can be computed.
- Dry and fresh water saturated volcanics. These formations generally exhibit high resistivity values. Note that the inference of fresh water saturation is normally based on geographic and elevation information, and that the fresh water cannot normally be directly detected in the TDEM data.
- Weathered volcanics (laterites) near the surface. These units are generally lower resistivity than volcanics and occur at the surface.

Damming structures are inferred with TDEM by distorted soundings, and by soundings which transition between detection of sea water at great depth (basal) and soundings that map high resistivities to great depth (high-level).

Another objective of the present survey is to attempt to detect areas of anomalous basal mode groundwater. It is postulated that these occurrences may be formed by preferential leakage of high-level water into the basal mode over a limited spatial area. These anomalous occurrences are expected to be manifested in the TDEM data by a local increase in the depth to the basal seawater, or by an increase in the basal seawater resistivity (caused by mixing).



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Schematic Hydrogeologic Cross Section
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 3-1

Project No: 2144LWC

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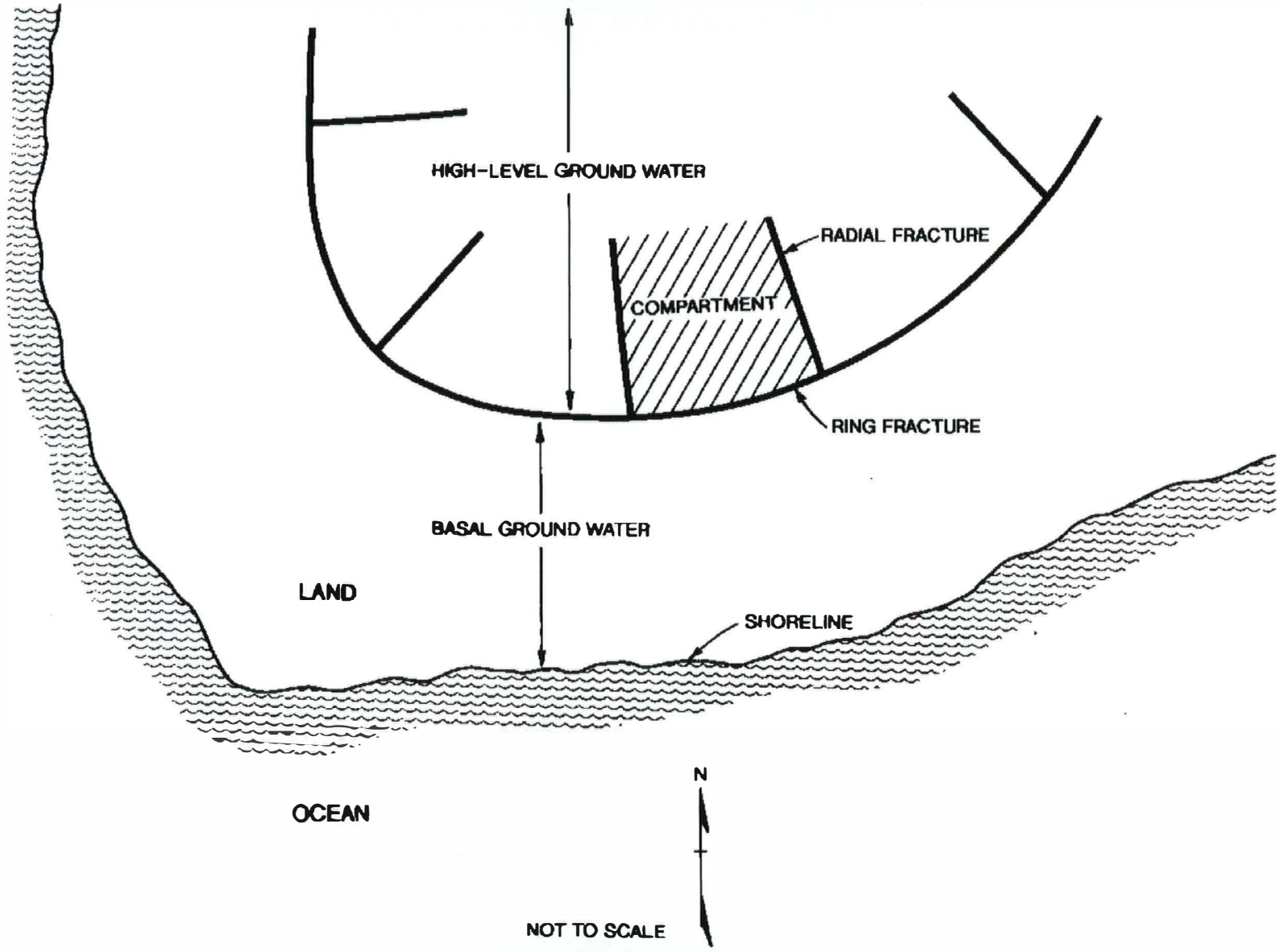

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Plan View of Schematic Geologic Model of Ring and Radial Fracture Patterns in a Caldera System
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 3-2

Project No: 2144LWC

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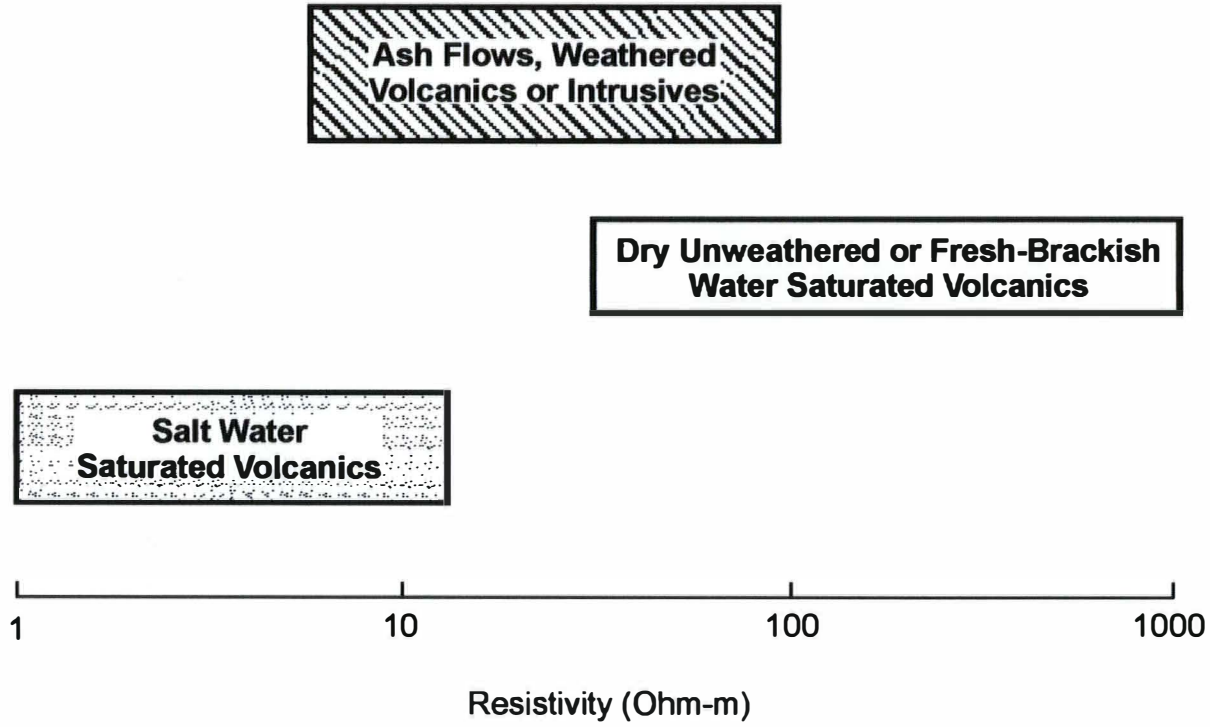

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Characteristic Resistivity Ranges Lanai, Hawaii

Lanai Water Company, Inc

Figure No: 3-3

Project No: 2144LWC

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4.0 DATA ACQUISITION AND LOGISTICS

The geophysical equipment utilized for the TDEM surveys was the Geonics EM37 and EM47 systems. The EM37 system consists of a motor-generator powered transmitter and portable receiver. Generally, the EM37 is used for exploration depths between 50 and 500 meters. The EM47 system consists of a very portable, battery powered transmitter, and portable receiver. The EM47 is used for exploration depths of less than about 100 meters. The EM47 has the capability of measuring earlier time gates than the EM37 and thus has better resolution of near surface (less than 50 meters) resistivity stratification. Table 2.1 shows that the EM47 was used at many of the sites for exploration of the anomalous basal mode water, where shallow exploration was required. The TDEM measurements were acquired using a central-loop array at each sounding site. The square transmitter loops were formed by using 12-guage insulated wire laid on the ground surface. The dimensions for the transmitter loops varied between 1,000 ft by 1,000 ft (Areas 1 and 2) to 100 ft by 100 ft (detail areas). A transmitter is placed at a point in the wire-loop, which drives current pulses through the wire. These current pulses induce eddy current flow in the subsurface. A receiver positioned in the center of the wire-loop records the decay of the secondary magnetic field due to these eddy currents induced in the subsurface.

For data quality control, comparisons of offset measurements were made at designated locations near the center of several soundings. The data acquired at each sounding center consisted of measurements at several different receiver gain settings and two transmitter frequencies in order to assure data quality and to obtain data over the largest possible time interval. The data were recorded at base frequencies of 3 Hz and 30 Hz for the EM37, and at base frequencies of 30 Hz and 300 Hz for the EM47. The data from each sounding were stored in a solid-state memory logger and transferred at the end of each day to a PC for nightly processing. A technical note describing the principles of TDEM with case histories is given in Appendix A.

A Blackhawk crew consisting of two people was employed for the TDEM surveys. Two personnel from Lanai Water Company also assisted in the fieldwork. TDEM loop locations were tied to known survey markers and landmarks (i.e. fences, roads) with a hip-chain and compass. In addition, a hand-held Global Positioning System (GPS) was also used to map the loop locations. During the seven days of fieldwork a total of 40 soundings were measured in the seven survey areas.

5.0 DATA PROCESSING

Processing of the TDEM data begins with averaging of the electromotive forces (emf's) recorded at positive and negative receiver polarities. Next, the recordings made at different amplifier gains and frequencies were combined to give one transient decay. The emf's in the various time gates of the decay curves were subsequently entered to an inversion program TEMIXXL (Interpex Ltd.) to obtain a one-dimensional geoelectric section that best matches the observed decay curve.

The TEMIXXL inversion program requires an initial model of the geoelectric section measured. The initial model includes the number of layers and the resistivities and thickness' for each of the layers. This model is usually derived from general knowledge of the geologic section or from data obtained from drill holes or electric logs. The inversion program is then allowed to adjust these parameters, so that the model curve converges to best fit the field data. The inversion program does not change the total number of layers within the model curve, but all other parameters floating freely or optionally can be held constant. To determine the influence of number of layers on the solution, separate inversions with a different number of layers are run. Normally, the model with the fewest number of layers which best fits the field data is used.

6.0 RESULTS AND DISCUSSION

6.1 Sounding Data

The inversion results for each sounding of this project are given in Appendix B. For each TDEM sounding, the following is given:

- A plot of the sounding data with the geoelectric model curve superimposed.
- A printout of tabulated data along with geoelectric section.

6.2 Results-Geoelectric Cross Sections

6.2.1 Area 1-North of Airport

Figure 2-1 shows the general location of Area 1, and Figure 6-1 shows a detailed location map of TDEM soundings taken in Area 1. The objective of the recent work is to refine the location of the inferred groundwater damming structure shown on figure 6-1 (red hatched area). Four TDEM soundings were taken in Area 1 (A1S2, A1S3, A1S4 and A1S5) using 1,000 ft by 1,000 ft transmitter loops. The previous TDEM soundings taken in this area are also shown on this map. In the previous report a geoelectric cross section (D-D') was created through soundings LC1 and LC45. Soundings A1S3 and A1S5 were taken along the path of this section and figure 6-2 shows the updated geoelectric cross-section, incorporating this data. The new soundings both indicate a damming structure beneath them. Using this data, the groundwater damming structure has been moved about 800 feet toward the west (seaward). The results of incorporating the recent TDEM soundings are given on Figure 6-3, in plan view. The TDEM soundings taken in this survey result in redefining the location of the groundwater damming structure about 800 to 1,000 feet further west in this study area.

6.2.2 Area 2-Maunalei Gulch (EM37 and EM47)

Figure 2-1 shows the general location of Area 2, and Figure 6-4 shows a detailed location map of TDEM soundings taken in Area 2. The objective of the recent work is to refine the location of the inferred groundwater damming structure shown on figure 6-4 (red hatched area). Six TDEM soundings were taken in Area 2. Sounding A2S1 was placed on the eastern flank Maunalei Gulch, and the EM37 system with a 1,000-ft by 1,000-ft transmitter loop was utilized. Soundings A2S2 through A2S6 were placed in Maunalei Gulch, and the EM47 system with 200 ft by 200 ft transmitter loops were used. The sounding results for A2S1 are summarized in Table 6.1 below.

Table 6.1

Sounding Results for A2S1

Area 2-Maunalei Gulch

Layer Number	Resistivity (ohm-m)	Thickness (feet)	Elevation (feet)	Interpretation
1	13	98	984 to 886	Laterite and Altered Volcanics
2	925	951	886 to -65	Volcanics, Fresh/Brackish water saturated below sea level
3	2.4		-65 to ?	Salt water saturated volcanics.

This sounding indicates a very thin basal fresh/brackish water lens. Based on this data the location of the main damming structure shown on Figure 6-4 does not appear to change from the previous interpretation. The elevation of the salt-water saturated volcanics is only 65 feet below sea level, and thus the basal fresh/brackish water resource is expected to be very poor in this area.

The geoelectric cross-section created from the EM47 soundings taken within Maunalei Gulch is shown on Figure 6-5. In all of these soundings nearly the same resistivity stratification is derived. The cross-section is generally a 4-layer section with a thin surficial resistive layer (greater than 100 ohm-m), underlain by a more conductive (15 to 25 ohm-m) layer, underlain by a relative resistive (38 to 160 ohm-m) layer, underlain by a very conductive (2.7 to 9 ohm-m) layer. The uppermost layer is interpreted as streambed gravels. The second layer is interpreted as Laterite (weathered volcanics). The third layer is interpreted as dry volcanics above sea level, with possible brackish water saturation below sea level. The fourth layer is interpreted as a geologic structure (i.e. rift zone). This interpretation is based on the fact that the very conductive fourth layer occurs above or very near sea level across the entire section. Groundwater production within this structure is expected to be highly variable. Past groundwater exploration within these structures has yielded poor results.

6.2.3 Area 3-Maunalei Gulch-Detailed (EM47) Work

Figure 6-6 shows the TDEM transmitter loop layout in this area. Seven EM47 soundings utilizing 100-ft by 100-ft loops were taken in Area 3. These soundings were taken across the mouth of Maunalei Gulch at an elevation of about 12 meters (40 feet). The objective of these soundings was to explore for anomalous basal groundwater occurrences. The geoelectric cross-section created from these soundings is given on figure 6-7. For all of these soundings a three-layer section was interpreted. This section is comprised of a surficial, relative resistive (39 to 100 ohm-m) layer, underlain by a very conductive (2.2 to 9.8 ohm-m) layer, which is underlain by another very conductive (less than 2 ohm-m) layer. The second, conductive layer in the section is detected well above sea level across the geoelectric section. The anomalous layer is interpreted to be caused by a geologic structure. The basal, very conductive layer may be caused by this structure, or may be due to salt-water saturated volcanics.

soundings. Consequently, wells in this area will likely produce low volume and/or brackish water.

6.2.4 Area 4-Club Lanai/Kahea Gulch-Detailed (EM47) Work

Figure 6-8 shows the TDEM transmitter loop layout in this area. Five EM47 soundings utilizing 100-ft by 100-ft loops were taken in Area 4. These soundings were taken across the mouth of Kahea Gulch at an elevation of about 9 meters (30 feet). The objective of these soundings was to explore for anomalous basal groundwater occurrences. Also shown on this figure is the location and results for sounding L1S1 taken in previous TDEM surveys in this area. The geoelectric cross-section created from the EM47 soundings is given on figure 6-9. The geoelectric cross-section is dominated by a moderately conductive (19 to 36 ohm-m) layer which is mapped to a depth of greater than about 100 feet below sea level. Beneath this layer a very conductive (2 to 2.8 ohm-m) layer is mapped. On the Northwest half of the section a surficial resistive (greater than 100 ohm-m) layer is mapped. The basal conductive layer in this section is interpreted as salt water saturated volcanics. This layer occurs at unexpected large depth (greater than 100 feet below sea level) considering the short distance (600 to 700 feet) from the ocean. These results suggest that this area may contain anomalous basal fresh/brackish water resources. However, this may be misleading, since the lateral extent of this anomalous occurrence is not determined with the existing soundings, and the anomalous depth of the salt water saturated volcanics could be caused by changes (decrease) in permeability. Also, the intermediate resistivities mapped in the overlying unit may also indicate significant mixing of the salt water (below sea level) or a weathered volcanic. The depth of the interpreted salt-water saturated volcanics interpreted in these soundings is consistent with the results from sounding L1S1 taken in the previous TDEM surveys.

6.2.5 Area 5- Haua Gulch-Detailed (EM47) Work

Figure 6-10 shows the TDEM transmitter loop layout in this area. Five EM47 soundings utilizing 100-ft by 100-ft loops were taken in Area 5. These soundings were taken across the mouth of Haua Gulch at an elevation of about 26 to 49 meters (85 to 160 feet). The objective of these soundings was to explore for anomalous basal groundwater occurrences. The geoelectric cross-section created from the EM47 soundings is given on figure 6-11. The geoelectric cross-section is dominated by a moderately conductive (20 to 67 ohm-m) layer which is mapped to an average depth of about 60 feet below sea level. Beneath this layer a very conductive (1.6 to 2.8 ohm-m) layer is mapped. On the Southeast end of the section, a highly resistive (343 ohm-m) layer overlies the very conductive basal layer. The basal conductive layer in this section is interpreted as salt water saturated volcanics. This layer occurs at modest depth (50 to 70 feet below sea level) considering the long distance (greater than 2,000 feet) from the ocean. The survey results from this area do not indicate a high potential for significant resources of basal fresh/brackish groundwater.

6.2.6 Area 6- Hauola Gulch-Detailed (EM47) Work

Figure 6-12 shows the TDEM transmitter loop layout in this area. Seven EM47 soundings utilizing 100-ft by 100-ft loops were taken in Area 6. These soundings were taken across the mouth of Hauola Gulch at an average elevation of about 15 meters (50 feet). The objective of these soundings was to explore for anomalous basal groundwater occurrences. The geoelectric cross-section created from the EM47 soundings is given on figure 6-13. For all of these soundings a three-layer section was interpreted. This section is comprised of a surficial, resistive (58 to 173 ohm-m) layer, underlain by a moderately conductive (13 to 19 ohm-m) layer, which is underlain by a very conductive (less than 2 ohm-m) layer. The basal conductive layer in this section is interpreted as salt water saturated volcanics. This layer occurs at moderately large depths (ranging from 40 to 80 feet below sea level), and roughly mimics the surface topography. The overlying, moderately conductive layer is interpreted as a unit with significant mixing of the salt water and/or a weathered volcanic. These results suggest that this area may contain better than normal basal fresh/brackish water resources. Caution should be exercised, since the extent of this anomalous occurrence is not determined with the existing soundings, and the depth of the salt water saturated volcanics could be impacted by changes (decrease) in permeability. Also, the intermediate resistivities mapped in the overlying unit may also indicate significant mixing of the salt water and/or a weathered volcanic.

6.2.7 Area 7- Unnamed Gulch East of Manele Road-Detailed (EM47) Work

Figure 6-14 shows the TDEM transmitter loop layout in this area. Also shown on this figure is the location and results for soundings taken in previous TDEM surveys in this area. Six EM47 soundings utilizing 100-ft by 100-ft loops were taken in Area 7. These soundings were taken across the Gulch east of the Manele Bay Road at an elevation of about 100 meters (330 feet). The objective of these soundings was to explore for anomalous basal groundwater occurrences. The geoelectric cross-section created from these soundings is given on figure 6-15. For all of these soundings a two-layer section was interpreted. This section is comprised of a surficial, resistive (79 to 380 ohm-m) layer, underlain by a very conductive (less than 3.4 ohm-m) layer. The upper layer is interpreted as dry unweathered volcanics. The second, conductive layer in the section is interpreted as seawater saturated volcanics beneath sounding A7S1, and as a geologic structure beneath the remainder of the soundings. The depth to the seawater-saturated volcanics beneath sounding A7S1 (approximately 40 feet) is consistent with the TDEM soundings taken in the previous surveys. The existence of a significant geologic structure in this area has also been confirmed in the previous surveys (reference figure 2-1). Groundwater production in this area is expected to be poor due to the geologic structure interpreted in the TDEM soundings. The EM47 TDEM soundings taken in this area where severely impacted by electrical interference. The interference had a frequency of about 20 kHz, and it is suspected that the noise was caused by the Very Low Frequency (VLF) transmitter on Honolulu. This VLF transmitter is used for submarine communications by the military.

7.0 CONCLUSIONS AND RECOMMENDATIONS

There are two main objectives of the recent TDEM surveys conducted on Lanai:

- To refine the location of the interpreted groundwater damming structure at selected locations (Areas 1 and 2), and
- To explore for anomalous basal groundwater occurrences (Areas 3-7).

The TDEM surveys conducted in Area 1 resulted in repositioning of the interpreted groundwater structure approximately 800 to 1,000 feet further west (seaward) than previously interpreted. This new position is shown on the summary map of Figure 7-1.

The TDEM surveys conducted in Area 2 show that the position of the main groundwater damming structure is unchanged; however a geologic structure (interpreted as a rift zone) was interpreted in Maunalei Gulch. The interpreted location of this structure is shown on the summary map of Figure 7-1.

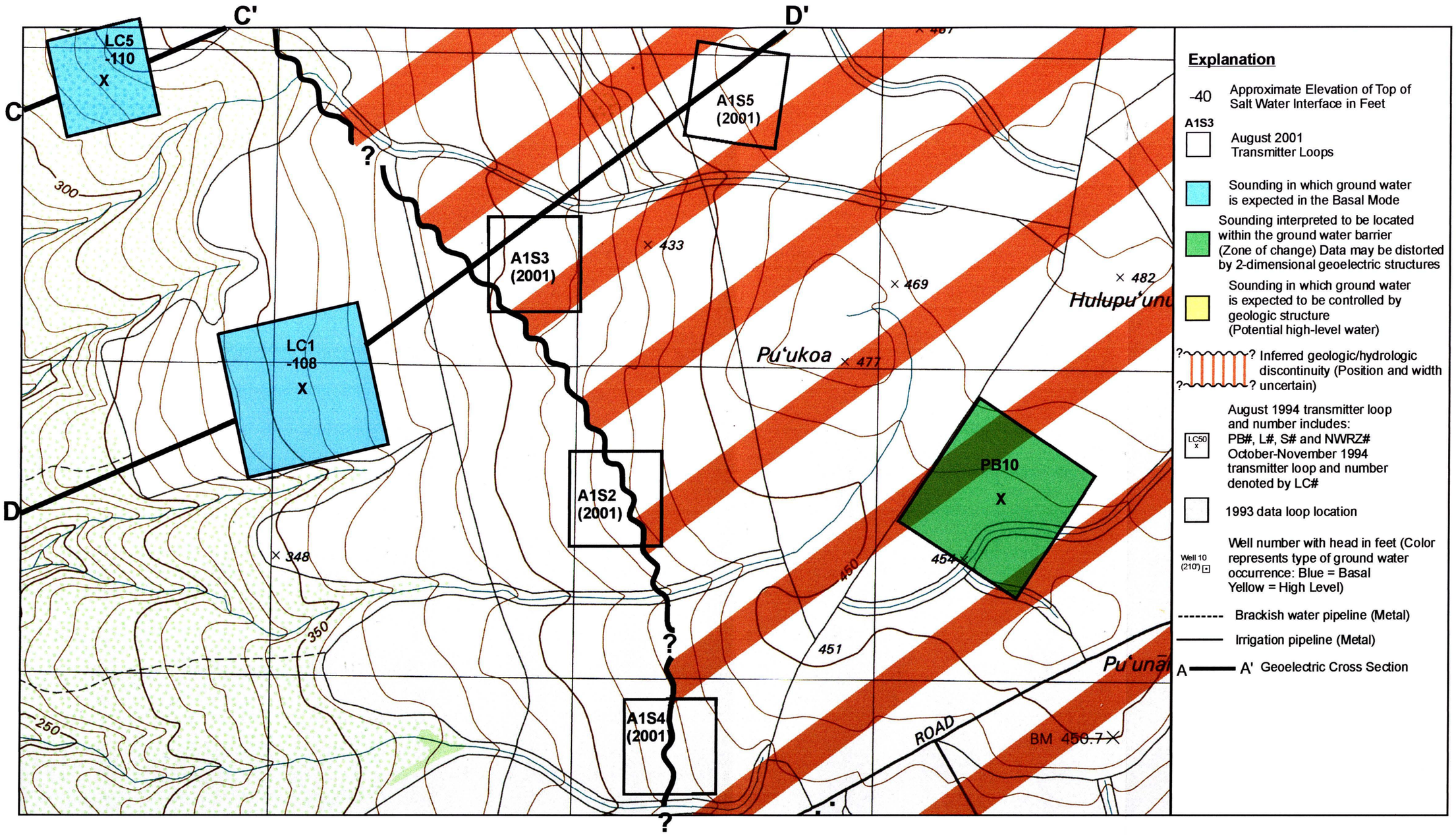
The results of the exploration for anomalous basal groundwater occurrences in Areas 3-7 are summarized in Table 7.1 below.

Table 7.1

Summary of Results from Areas 3-7

Area	Summary
3-Maunalei Gulch	Area impacted by interpreted rift zone. Expected to have poor groundwater resources.
4-Club Lanai/Kahea Gulch	Apparently anomalous basal lens compared to other areas on Lanai. Could have better than normal groundwater resources.
5-Haua Gulch	Expected poor groundwater resources.
6-Hauola Gulch	Possible better than normal basal lens compared to other areas on Lanai.
7-Unnamed Gulch East of Manele Road	Expected poor groundwater resources.

Of these 5 areas, Areas 4 and 6 may have better than normal basal groundwater resources compared to other basal mode occurrences on Lanai. This interpretation is based on the relative depth of the saltwater intrusion at the sites. At both sites the depth to saltwater intruded formations is deeper than expected. Other factors, such as a decrease of permeability of the formation, or existence of altered volcanics may contribute to this increase in depth of the saltwater intruded formations. Both of these conditions would result in low production wells.



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N W E S

0 1000 2000 3000
Scale in Feet

Area 1
EM37 Sounding Location Map
North of Airport, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-1

Project No: 2144LWC

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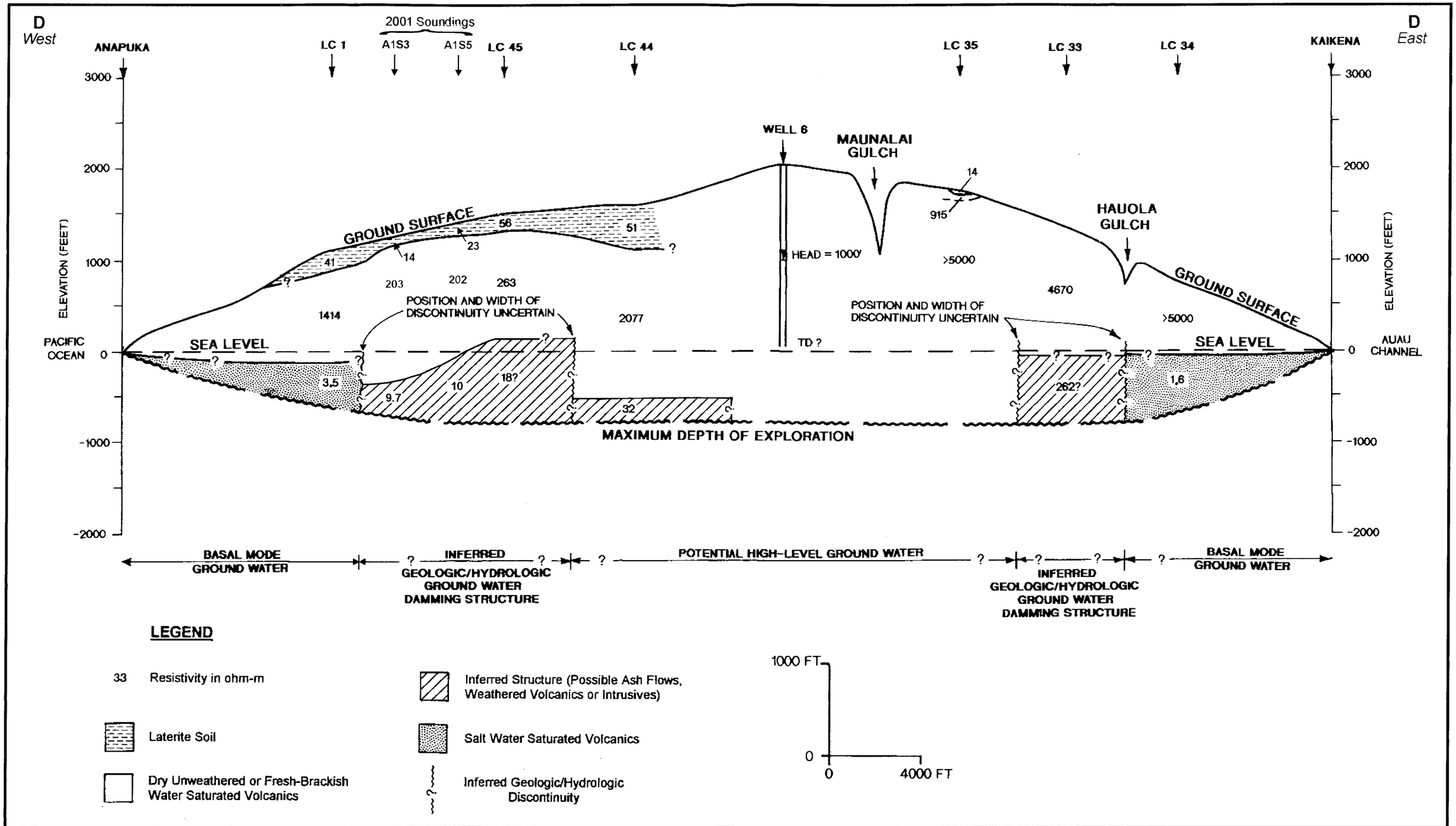

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Geoelectric
Cross Section D-D'
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-2

Project No: 2144LWC

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C'

D'

C

D

LC5
-110
X

LC1
-108
X

A1S5
(2001)

A1S3
(2001)

A1S2
(2001)

A1S4
(2001

PB10
X

300

250

350

× 348

× 433

× 469

× 482

× 477

× 454

450

451

Pu'ukoa

Hulupu'unu

Pu'unā

ROAD

BM 450.7

Revised Location of
Damming Structure

Original Location of
Damming Structure

?

Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

? Revised Location of Damming Structure ?

A1S3
August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

August 1994 transmitter loop and number includes: PB#, L#, S# and NWRZ# October-November 1994 transmitter loop and number denoted by LC#

LC50
x

1993 data loop location

Well 10
(210')

Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

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Blackhawk GeoServices

N
W E
S

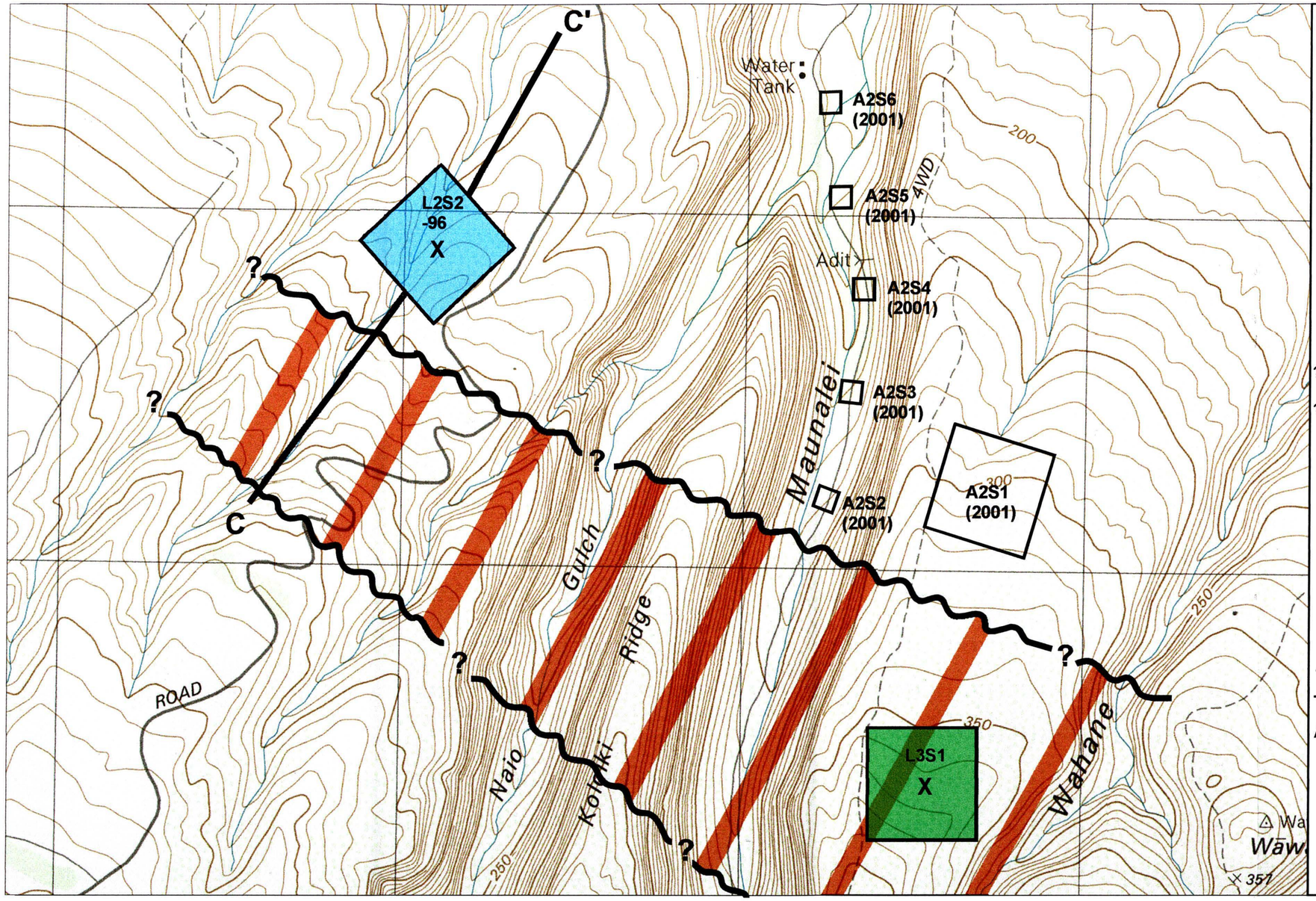
0 1000 2000 3000
Scale in Feet

Area 1
EM37 Soundings and Interpretation
North of Airport, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-3

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area1_Interp.cdr



Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

A2S6 August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

LC50 August 1994 transmitter loop and number includes: PB#, L#, S# and NWRZ# October-November 1994 transmitter loop and number denoted by LC#

1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N W E S

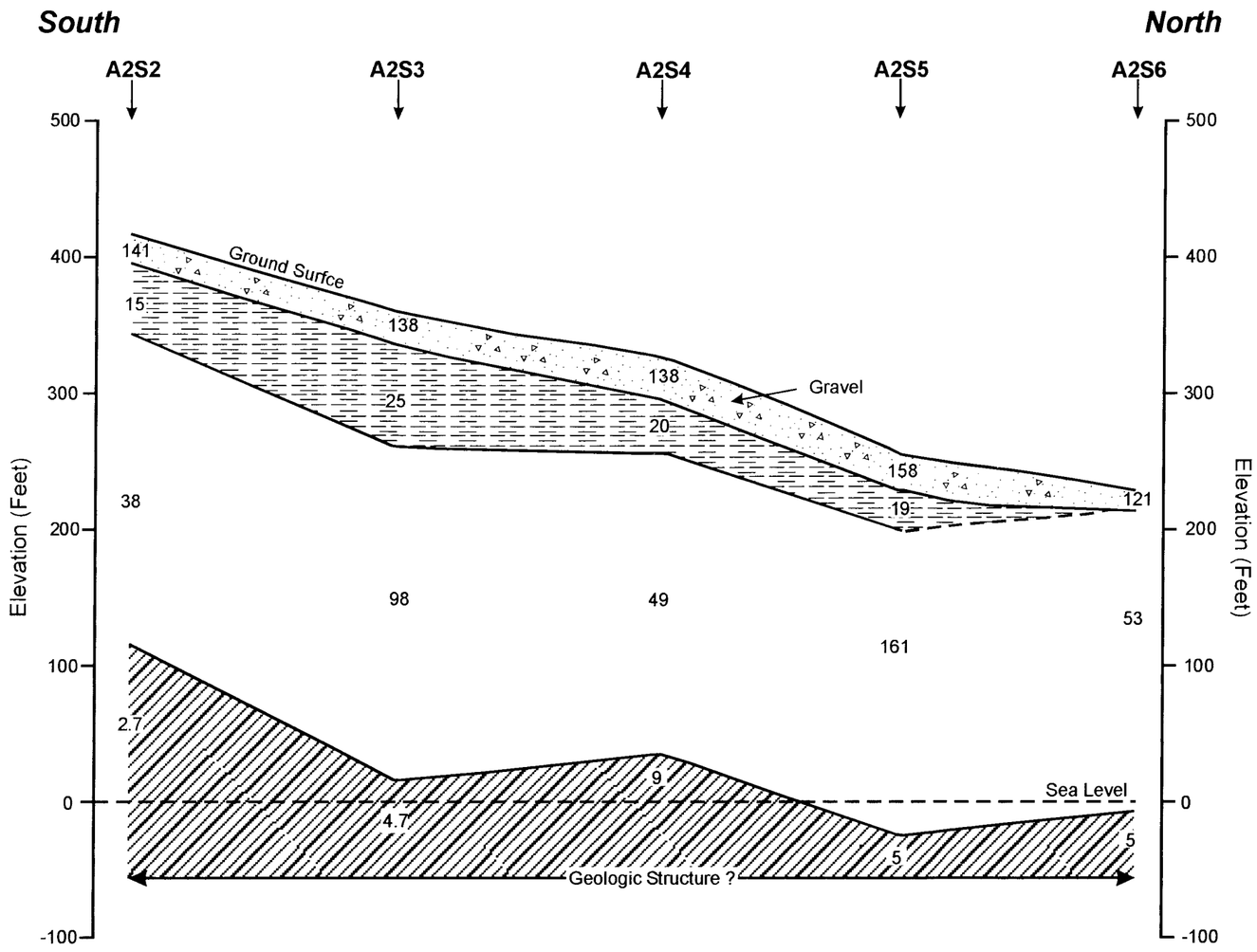
0 1000 2000 3000
Scale in Feet

Area 2
Sounding Location Map
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-4

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area2.cdr



Explanation

53 Resistivity in ohm-m

Laterite Soil

Dry Unweathered or Fresh-Brackish Water Saturated Volcanics

Inferred Structure (Possible Ash Flows, Weathered Volcanics or Intrusives

Salt Water Saturated Volcanics

Inferred Geologic/Hydrologic Discontinuity

100' Scale in Feet

500'

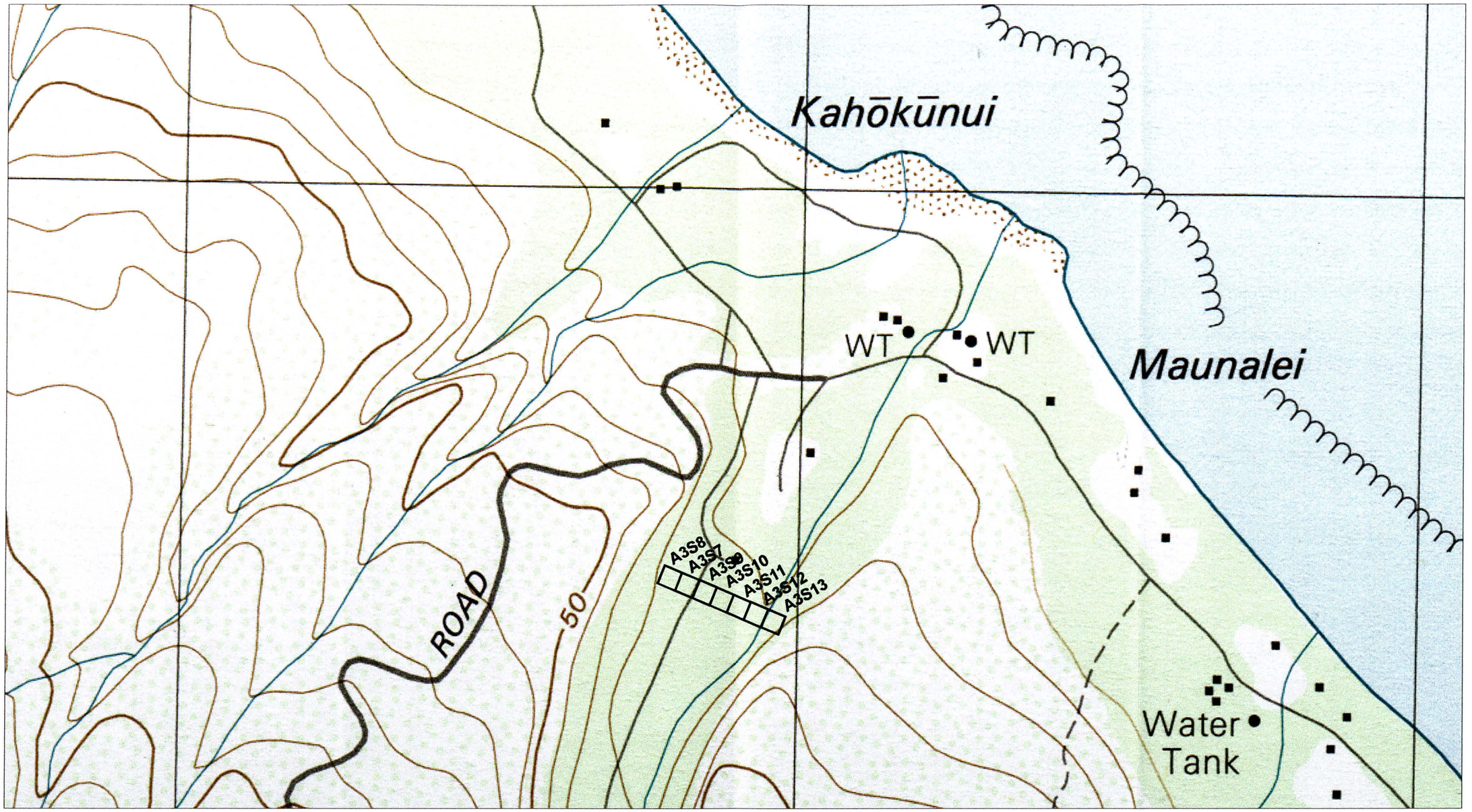
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 2
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-5

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area2.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

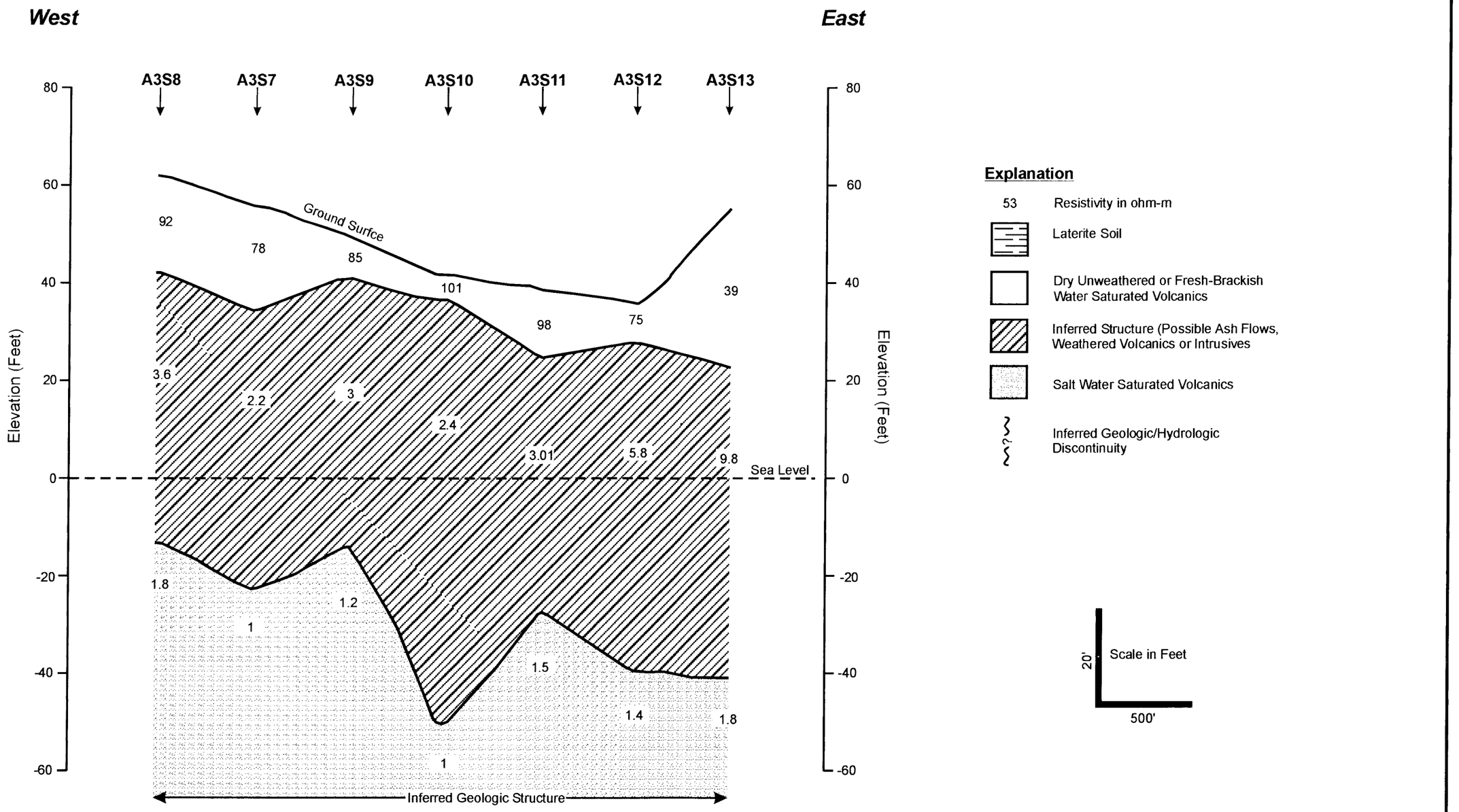
A3S8 August 2001 Transmitter Loops

Area 3
Detailed (EM47) Sounding Location Map
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-6

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area3.cdr



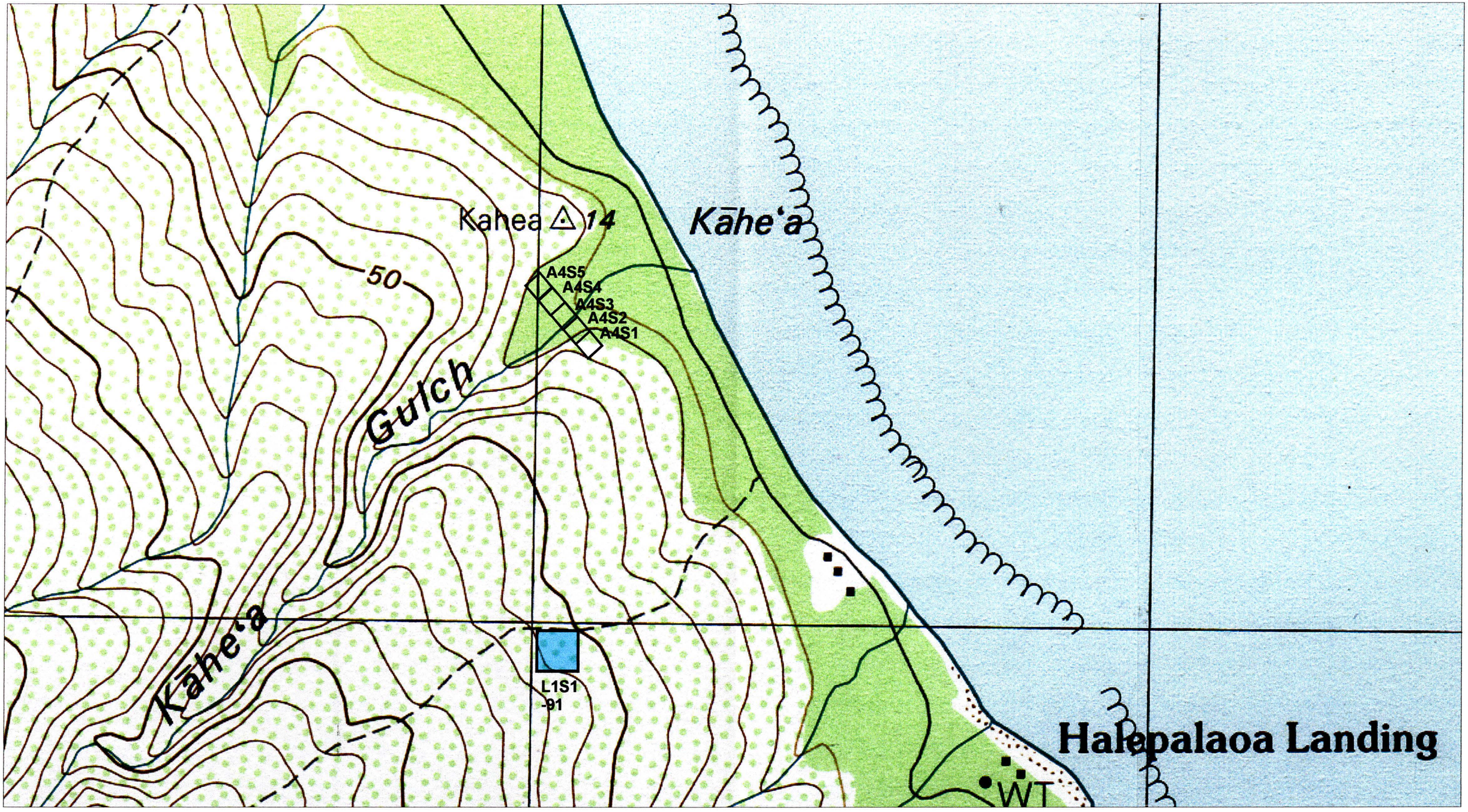
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 3
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-7

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area3.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N W E S

0 500 1000 1500
Scale in Feet

Explanation

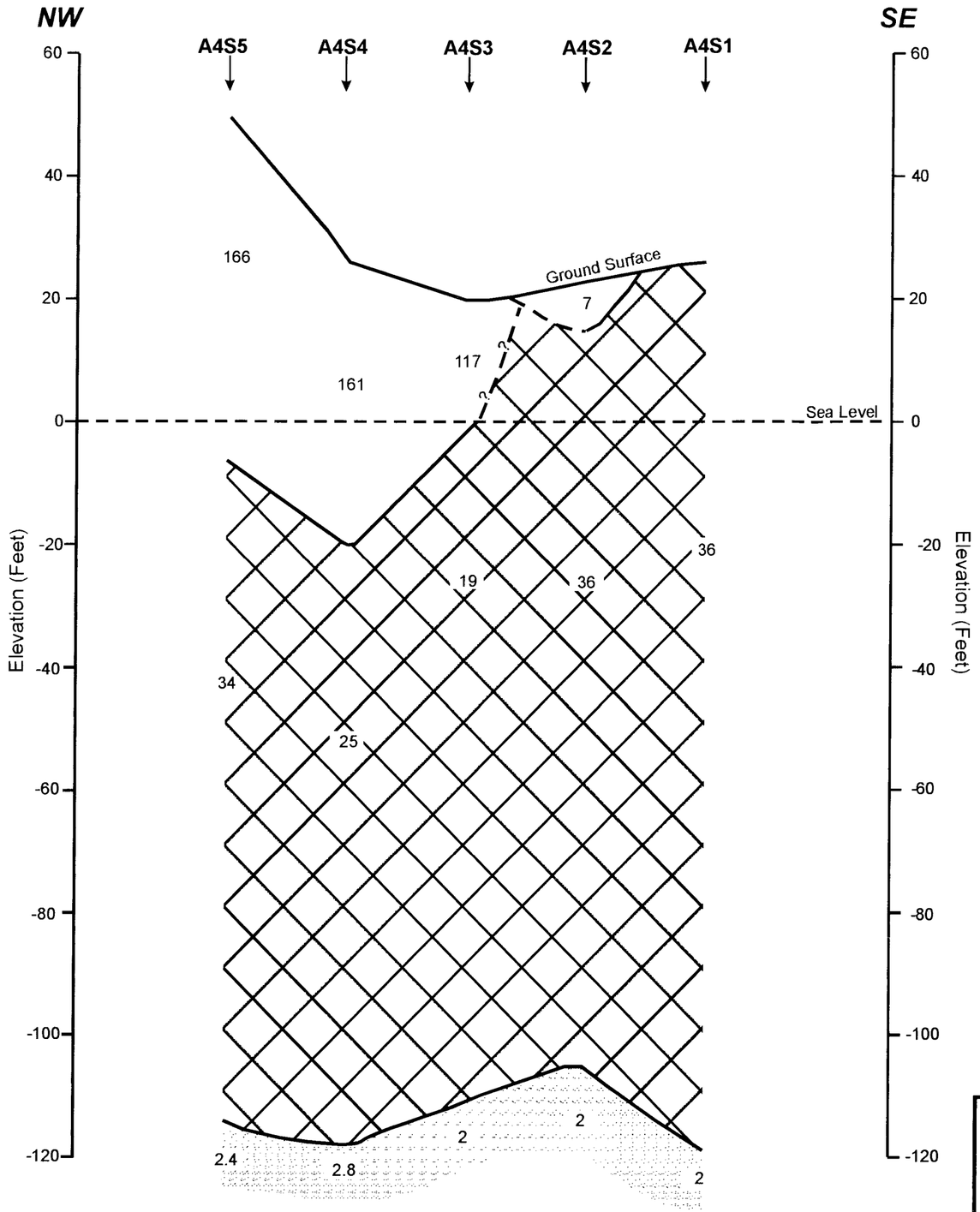
A4S1 August 2001 Transmitter Loops

Area 4
Detailed (EM47) Sounding Location Map
Club Lanai/Kāhe'a Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-8

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area4.cdr



Explanation

53 Resistivity in ohm-m

Laterite Soil

Dry Unweathered or Fresh-Brackish Water Saturated Volcanics

Inferred Structure (Possible Ash Flows, Weathered Volcanics or Intrusives

Salt Water Saturated Volcanics

Weathered Volcanics or Sea Water Mixing Below Sea Level

Inferred Geologic/Hydrologic Discontinuity

20'
Scale in Feet
100'

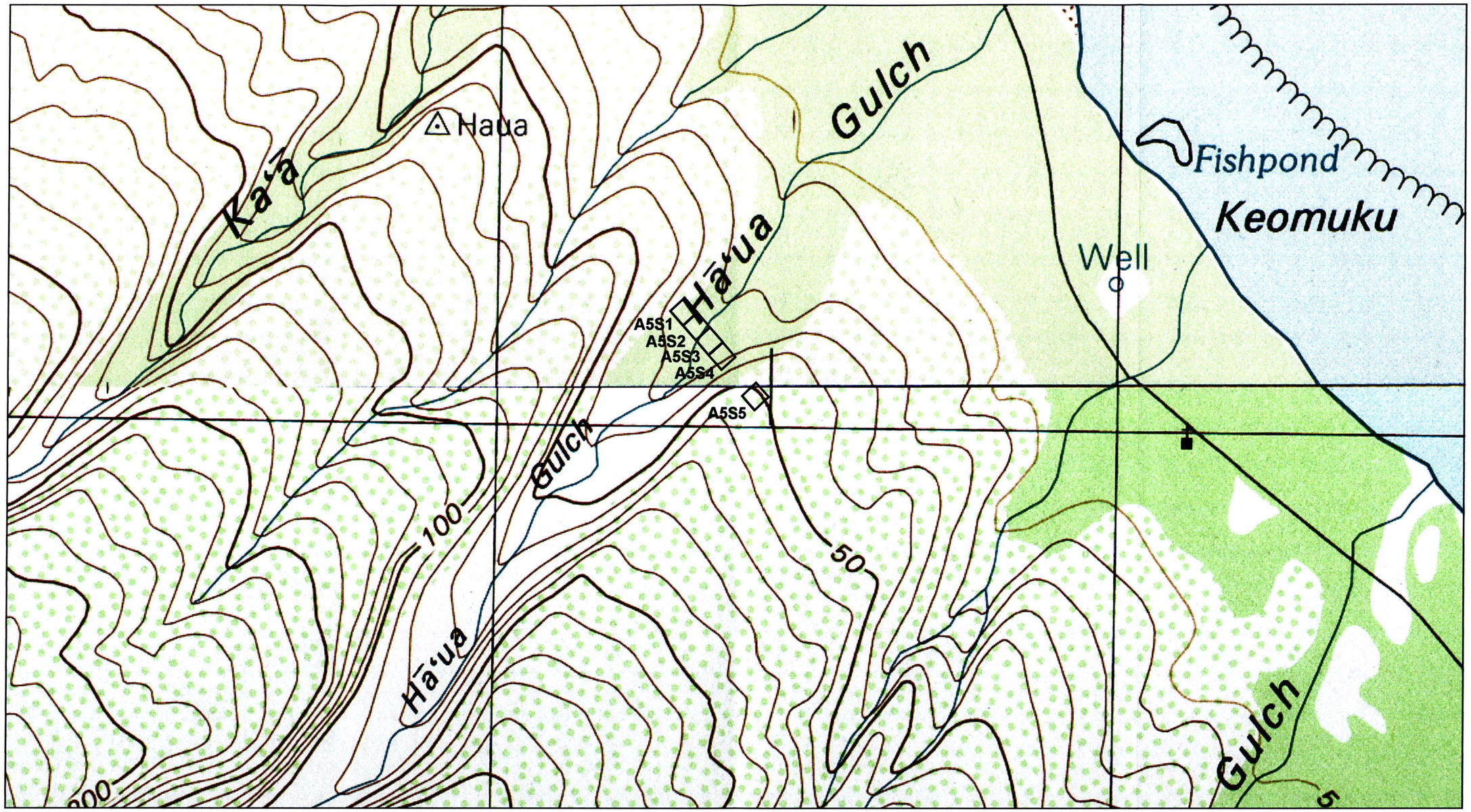
BLACKHAWK
GeoSciences
a division of
Blackhawk GeoServices

Geoelectric
Cross Section Area 4
Club Lanai/Kahea Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-9

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area7.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

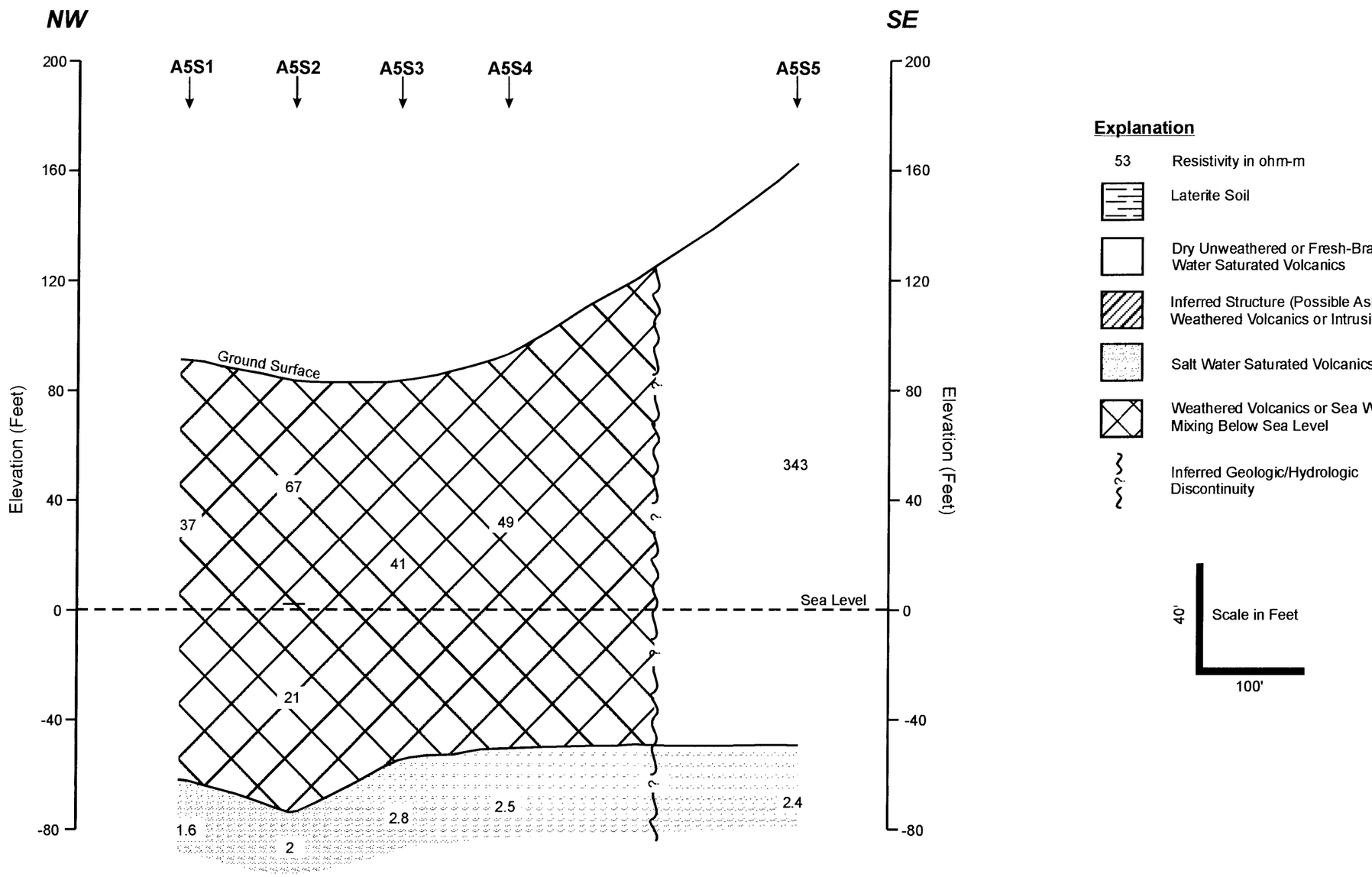
A5S1 August 2001 Transmitter Loops

Area 5
Detailed (EM47) Sounding Location Map
Haua Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-10

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area5.cdr



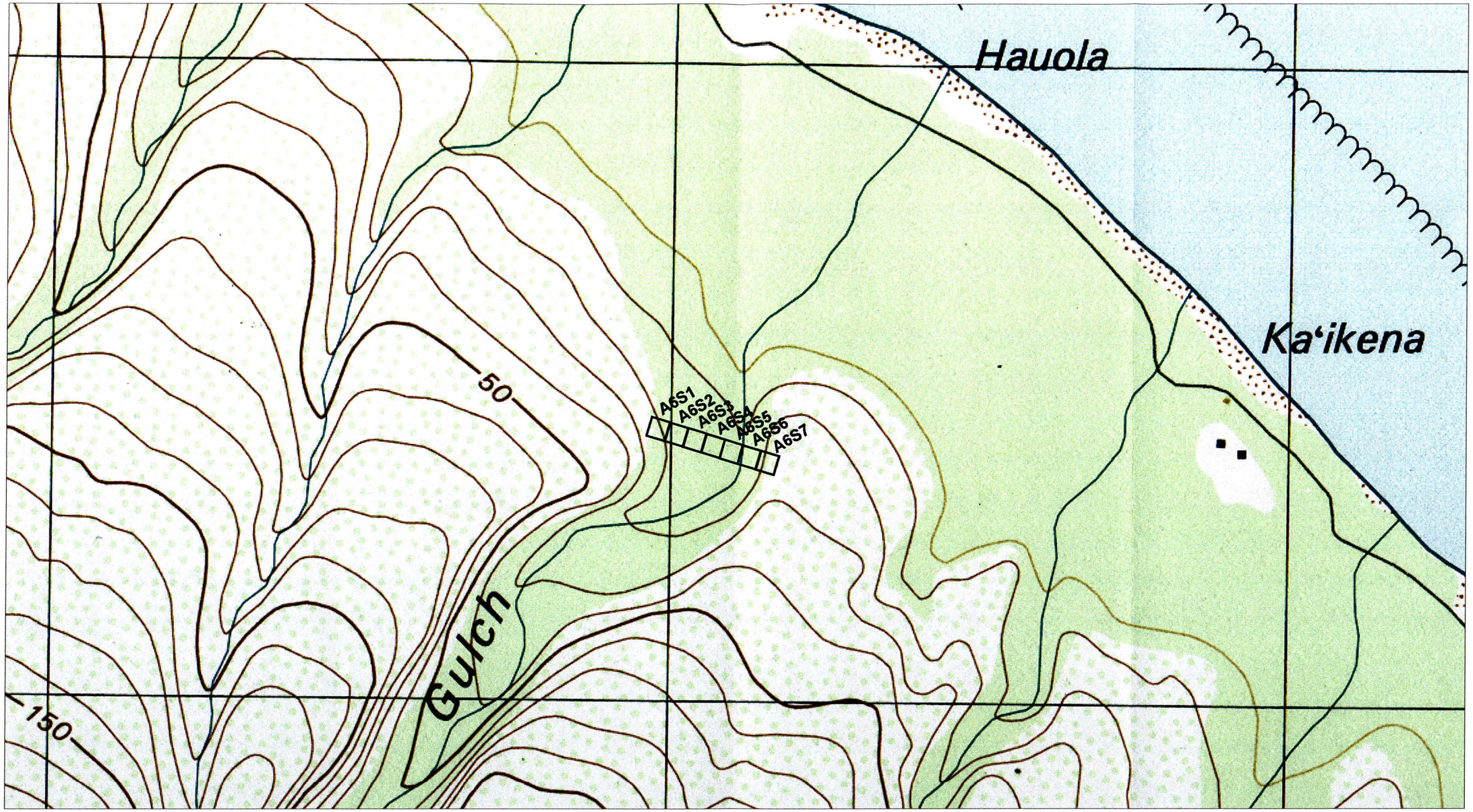
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 5
Haua Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-11

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area5.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

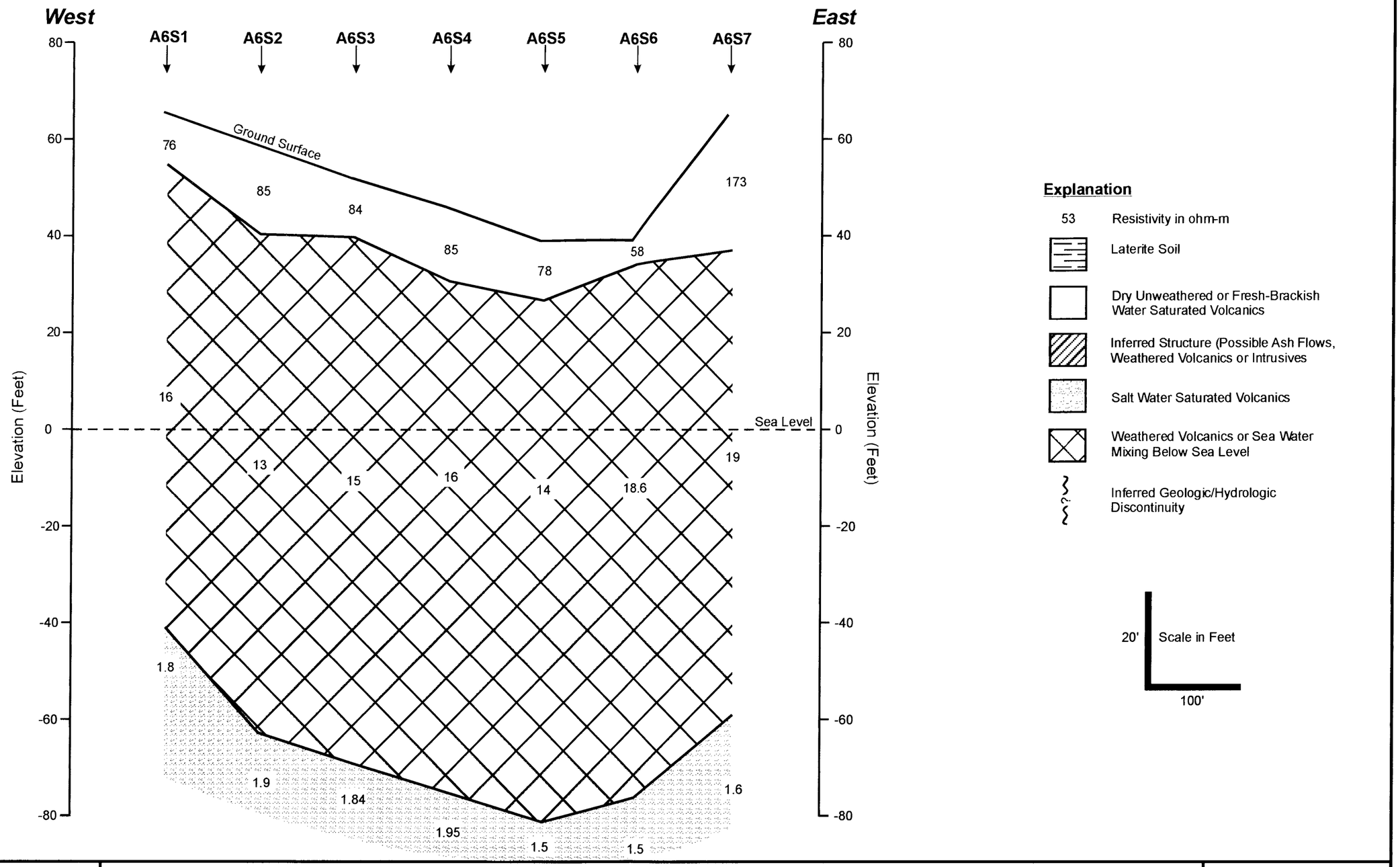
A6S1 August 2001 Transmitter Loops

Area 6
Detailed (EM47) Sounding Location Map
Hauola Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-12

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area6.cdr



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a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 6
Hauola Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-13

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area6.cdr

H'

2 (1993)
-46

X

A7S1 A7S2 A7S3 A7S4 A7S5 A7S6

2001 Soundings

1 (1993)
-40

X

MB Well 1
-2

Manele Well
(1.1')

150

440

Light
US COAST GUARD

2

Mānele
Bay

H

Hulopo'e
Beach

Hulopo'e
Bay

Leinohaunui
Point

E
N DISTRICT

Puupehe

Rock Shoal

Sharks Bay

Explanation

A7S1
August 2001
Transmitter Loops

N
W E
S

0 500 1000 1500
Scale in Feet

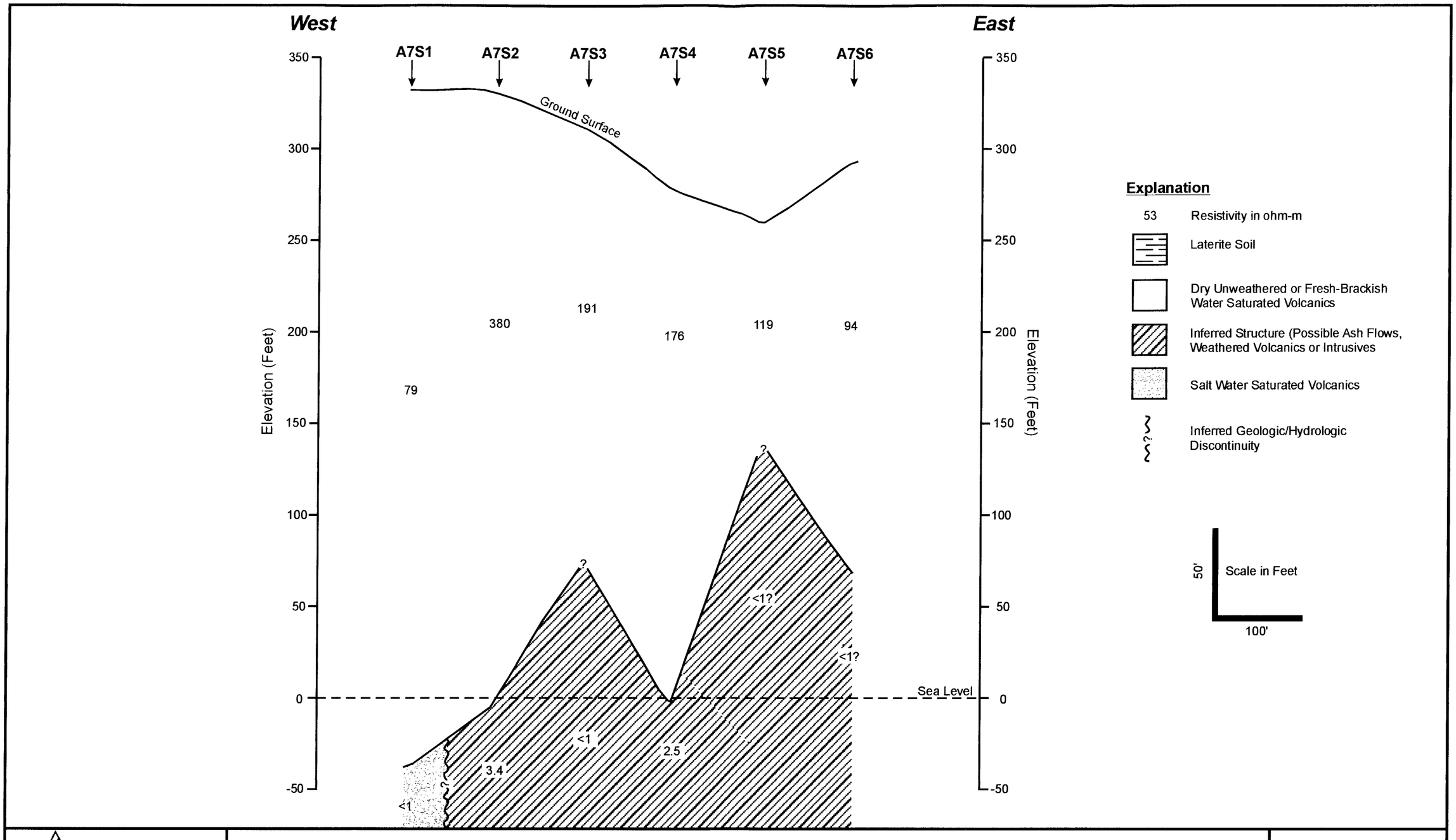
BLACKHAWK
GeoSciences
a division of
Blackhawk GeoServices

Area 7
Detailed (EM47) Sounding Location Map
Unnamed Gulch East of Manele Road,
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-14

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area7.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric Cross Section Area 7
Unnamed Gulch East of Manele Road,
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-15

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area7.cdr

MAP GOES HERE

C'

D'

C

D

LC5
-110
X

LC1
-108
X

A1S5
(2001)

A1S3
(2001)

A1S2
(2001)

A1S4
(2001)

PB10
X

?

300

350

250

× 348

× 433

× 469

× 482

× 477

451

454

450

Hulupu'unu

Pu'ukoa

Pu'unā

ROAD

BM 450.7

Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

A1S3 August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? ? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

LC50 August 1994 transmitter loop and number includes: PB#, L#, S# and NWRZ# October-November 1994 transmitter loop and number denoted by LC#

1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N W E S

0 1000 2000 3000
Scale in Feet

Area 1
EM37 Sounding Location Map
North of Airport, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-1

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area1.cdr

LANAI NORTH, HAWAII
MAUI COUNTY

KALOHI CHANNEL

PACIFIC OCEAN

TREND OF NORTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTH RIFT ZONE

A' B' H' C' D' E' F' G'

A B C D E F G H

LEGEND

-40 APPROXIMATE ELEVATION OF TOP OF SALT WATER INTERFACE IN FEET

SOUNDING IN WHICH GROUND WATER IS EXPECTED IN THE BASAL MODE

SOUNDING INTERPRETED TO BE LOCATED WITHIN THE GROUND WATER BARRIER (ZONE OF CHANGE)

SOUNDING IN WHICH GROUND WATER IS EXPECTED TO BE CONTROLLED BY GEOLOGIC STRUCTURE (POTENTIAL HIGH-LEVEL WATER)

? ? INFERRED GEOLOGIC/HYDROLOGIC DISCONTINUITY (POSITION AND WIDTH UNCERTAIN) TDEM SOUNDING MAY BE DISTORTED BY 2-DIMENSIONAL GEOELECTRIC STRUCTURES ? ?

LC50 AUGUST 1994 TRANSMITTER LOOP AND NUMBER INCLUDES PB#, L#S# AND NWRZ#

OCTOBER - NOVEMBER 1994 TRANSMITTER LOOP AND NUMBER DENOTED BY LC#

1993 DATA LOOP LOCATION

WELL ID (207) WELL NUMBER WITH HEAD IN FEET

BRACKISH WATER PIPELINE (METAL)

IRRIGATION PIPELINE (METAL)

A A' GEOELECTRIC CROSS SECTION

N

DECLINATION 11.5° EAST

CEES BLACKHAWK GEOSCIENCES DIVISION

GEOPHYSICAL INTERPRETATION
TDEM SOUNDING SUMMARY MAP
LANAI WATER COMPANY, INC.
ISLAND OF LANAI, HAWAII

PROJECT NO. 9081-000

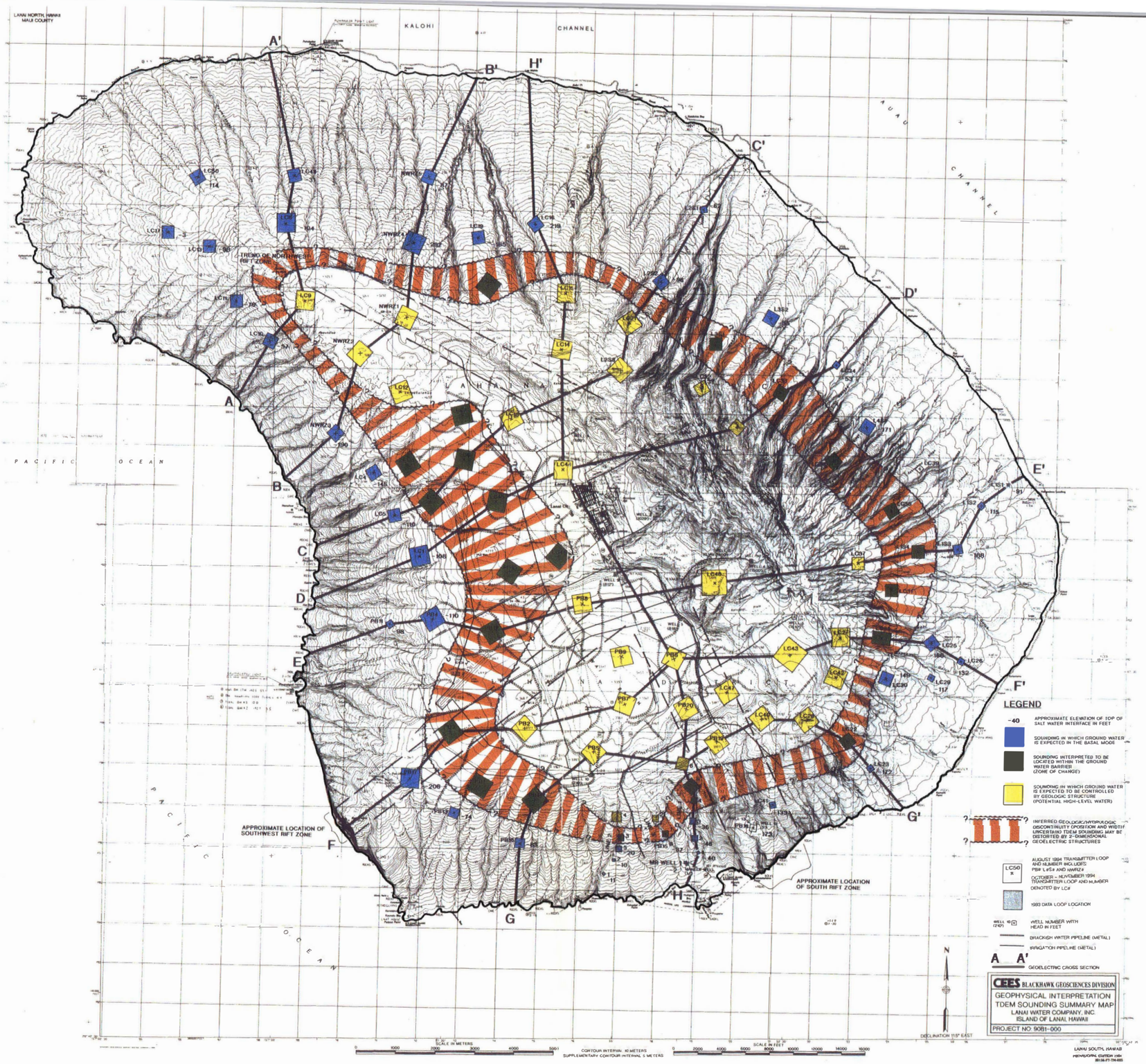
SCALE IN METERS 0 1000 2000 3000 4000 5000

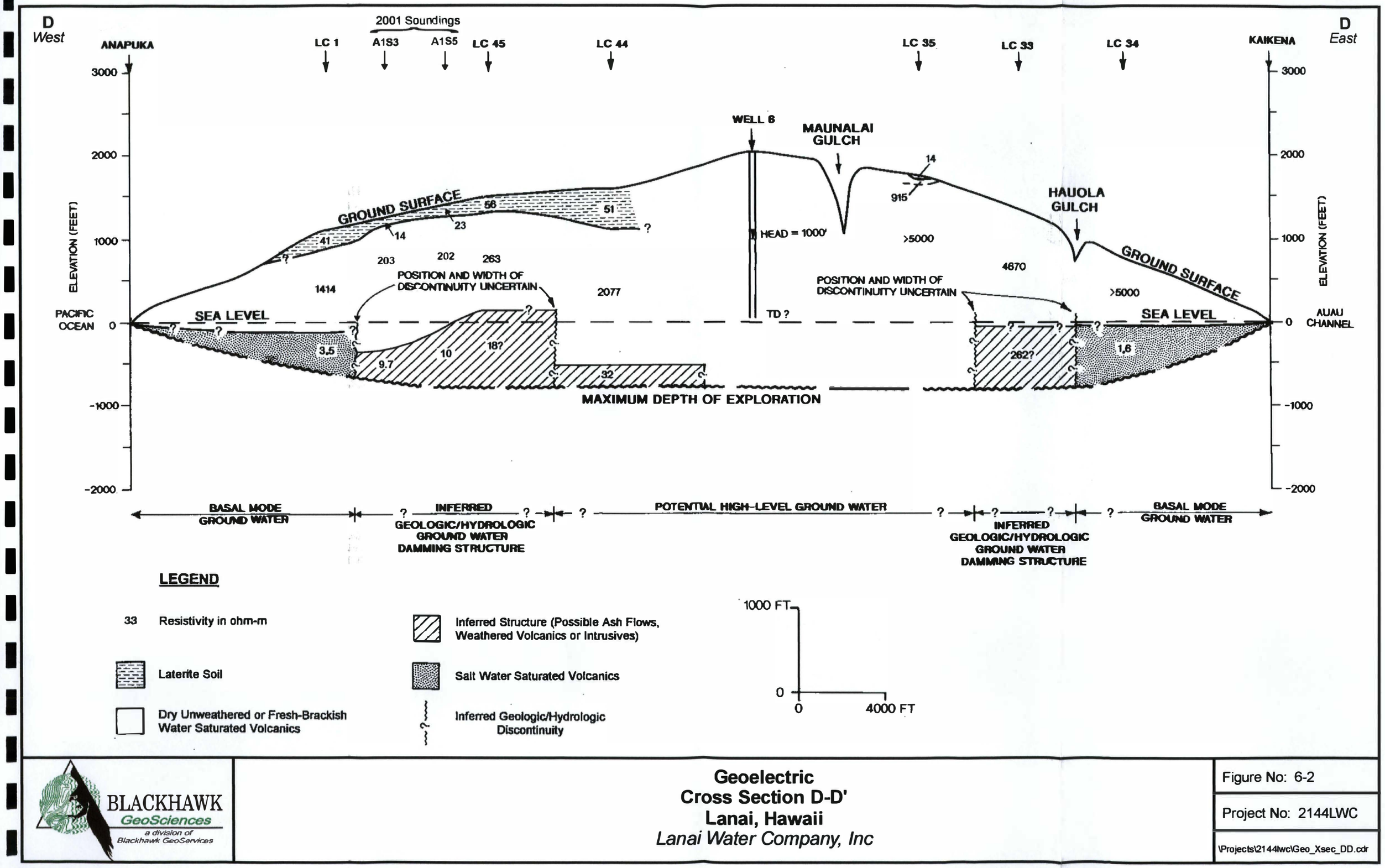
CONTOUR INTERVAL 10 METERS
SUPPLEMENTARY CONTOUR INTERVAL 5 METERS

SCALE IN FEET 0 2000 4000 6000 8000 10000 12000 14000 16000

LANAI SOUTH, HAWAII
PROVISIONAL EDITION 1994

LANAI NORTH, HAWAII
MAUI COUNTY





BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric Cross Section D-D'
Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-2

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_DD.cdr

C'

D'

C

D

LC5
-110
X

LC1
-108
X

A1S5
(2001)

A1S3
(2001)

A1S2
(2001)

A1S4
(2001)

PB10
X

300

× 433

× 469

× 482

Hulupu'unu

Pu'ukoa × 477

× 348

350

250

454

450

451

Pu'unā

ROAD

BM 456.7

Revised Location of
Damming Structure

Original Location of
Damming Structure

Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

Revised Location of Damming Structure

A1S3

August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

Inferred geologic/hydrologic discontinuity (Position and width uncertain)

LC50 x August 1994 transmitter loop and number includes: PB#, L#, S# and NWRZ# October-November 1994 transmitter loop and number denoted by LC#

1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N W E S

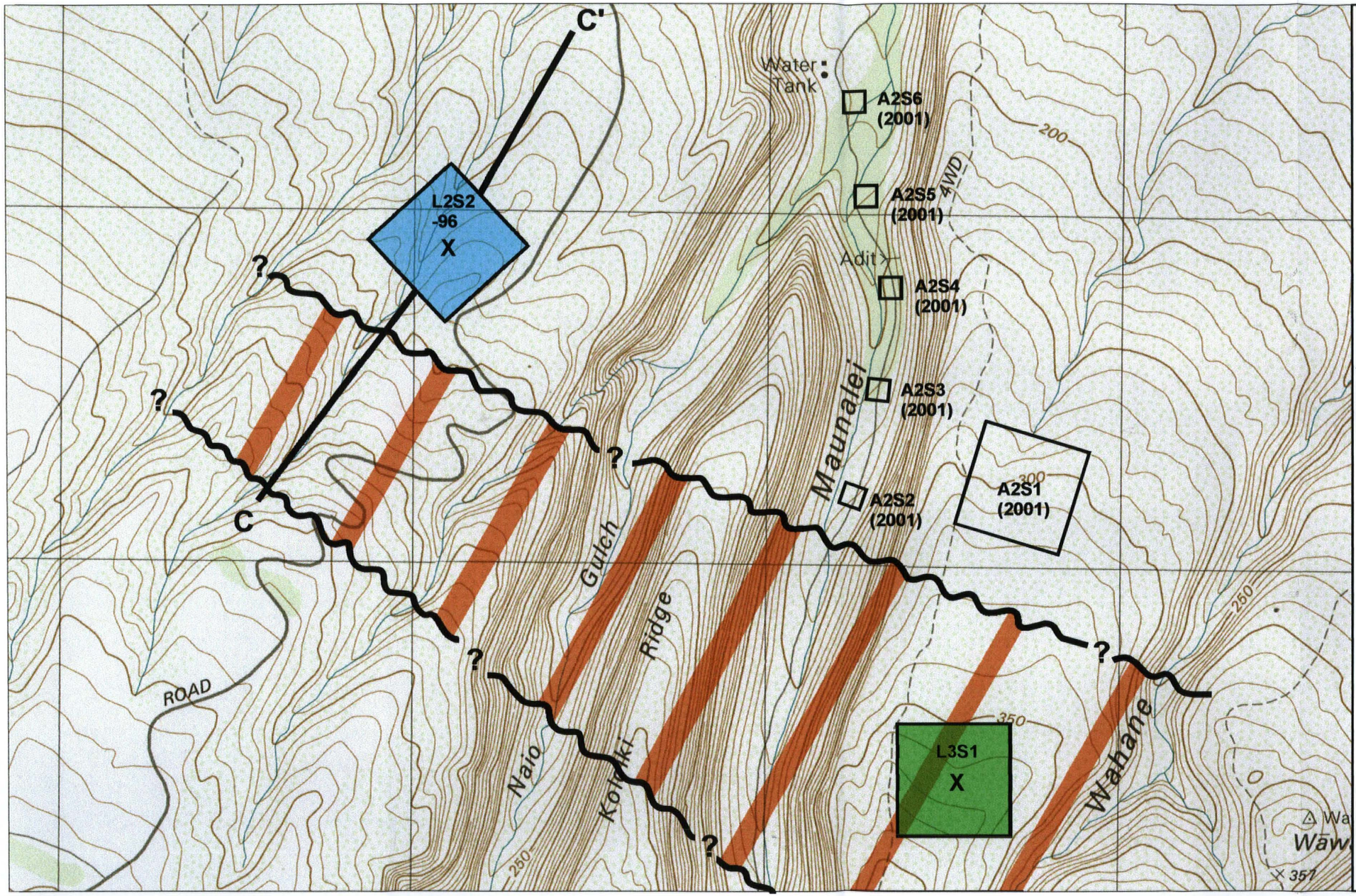
0 1000 2000 3000
Scale in Feet

Area 1
EM37 Soundings and Interpretation
North of Airport, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-3

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area1_Interp.cdr



Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

A2S6 August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

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Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? ? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

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1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

BLACKHAWK GeoSciences a division of Blackhawk GeoServices

N W E S

0 1000 2000 3000

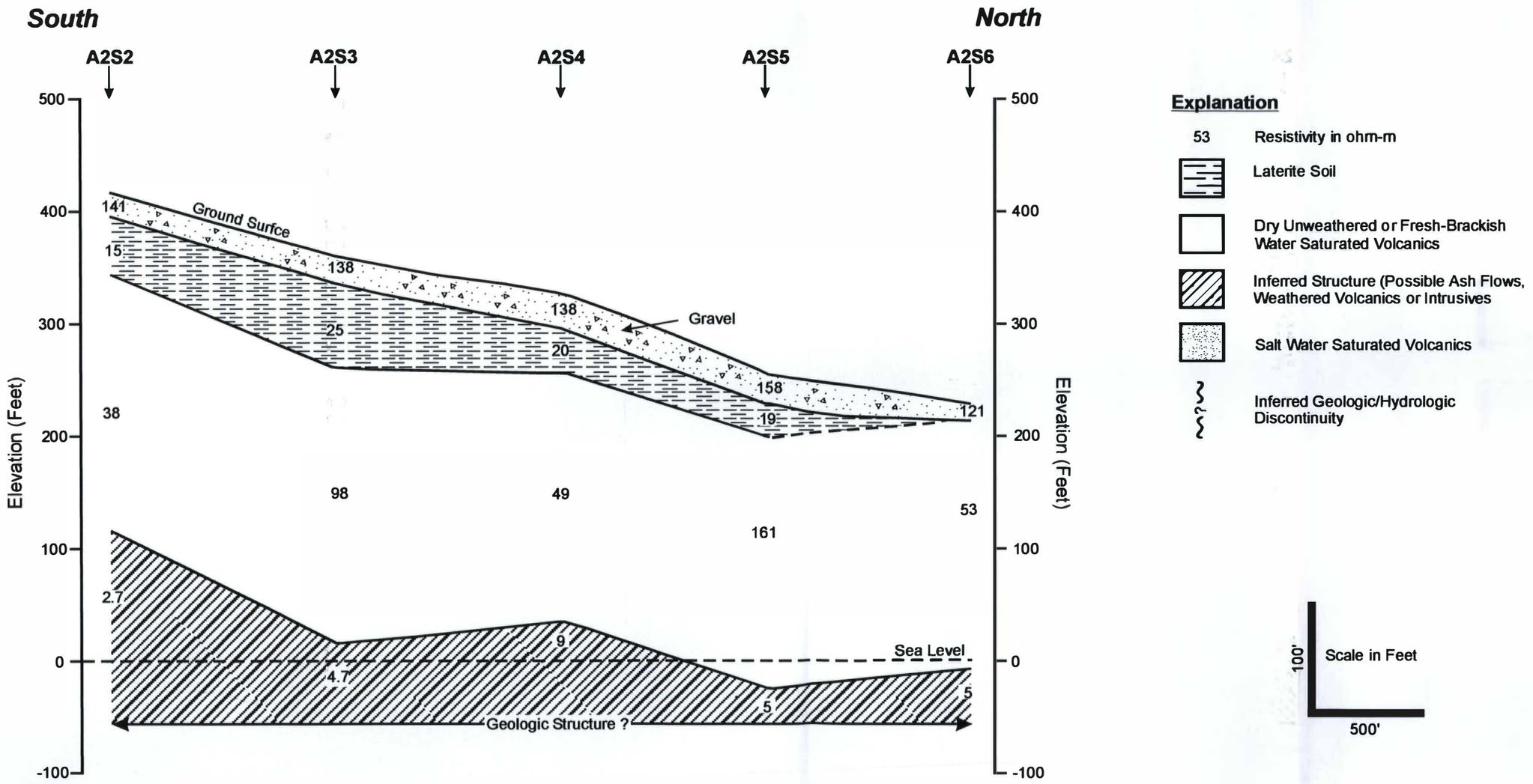
Scale in Feet

Area 2
Sounding Location Map
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-4

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area2.cdr



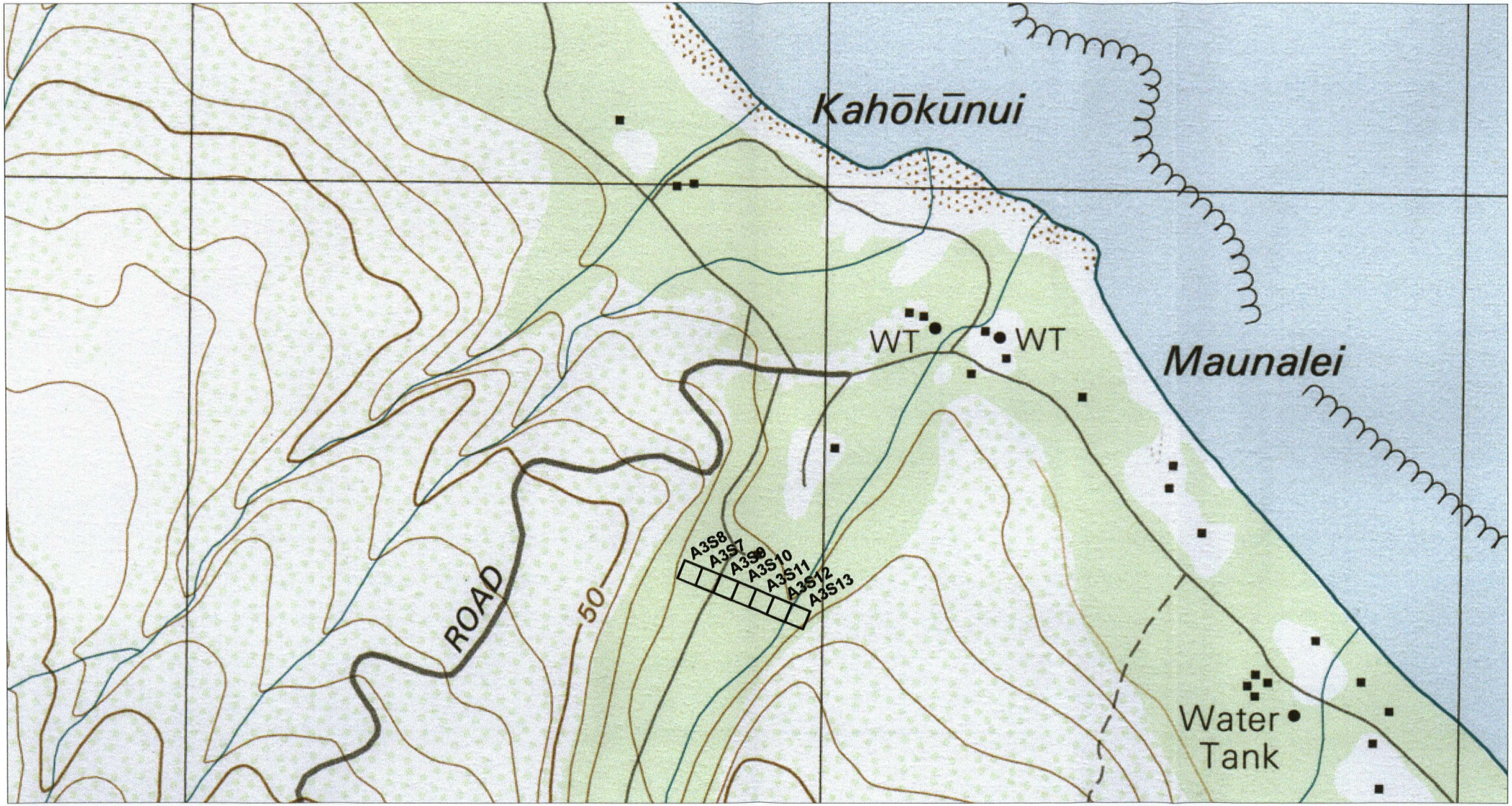
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 2
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-5

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area2.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

A3S8 August 2001 Transmitter Loops

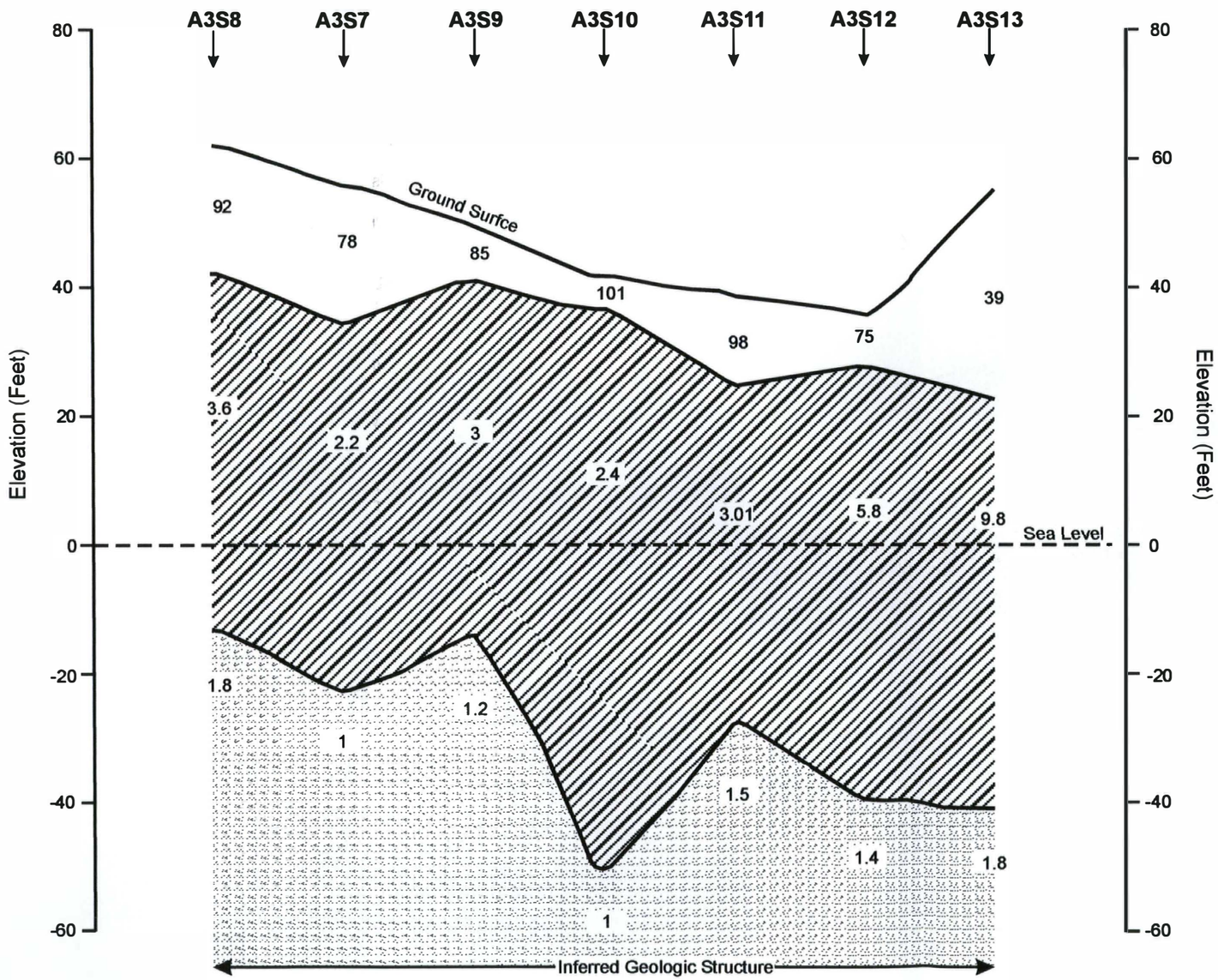
Area 3
Detailed (EM47) Sounding Location Map
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

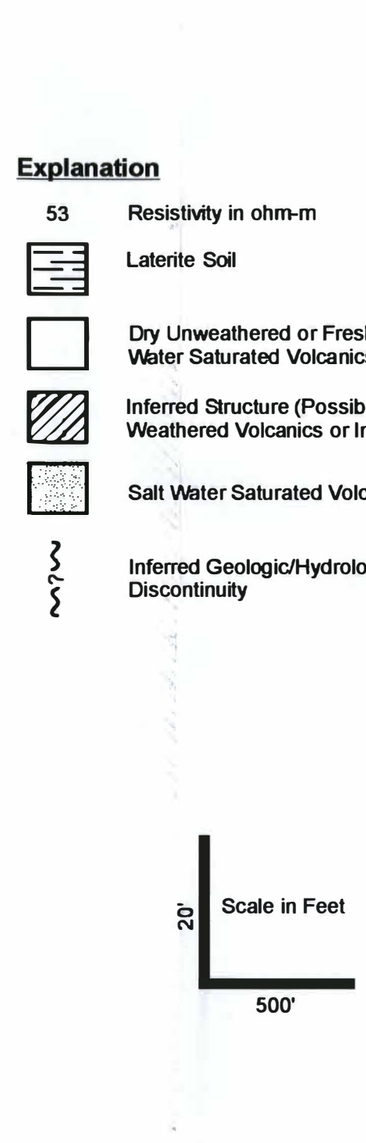
Figure No: 6-6

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area3.cdr

West **East**





Explanation

53 Resistivity in ohm-m

Laterite Soil

Dry Unweathered or Fresh-Brackish Water Saturated Volcanics

Inferred Structure (Possible Ash Flows, Weathered Volcanics or Intrusives

Salt Water Saturated Volcanics

Inferred Geologic/Hydrologic Discontinuity

20' Scale in Feet

500'

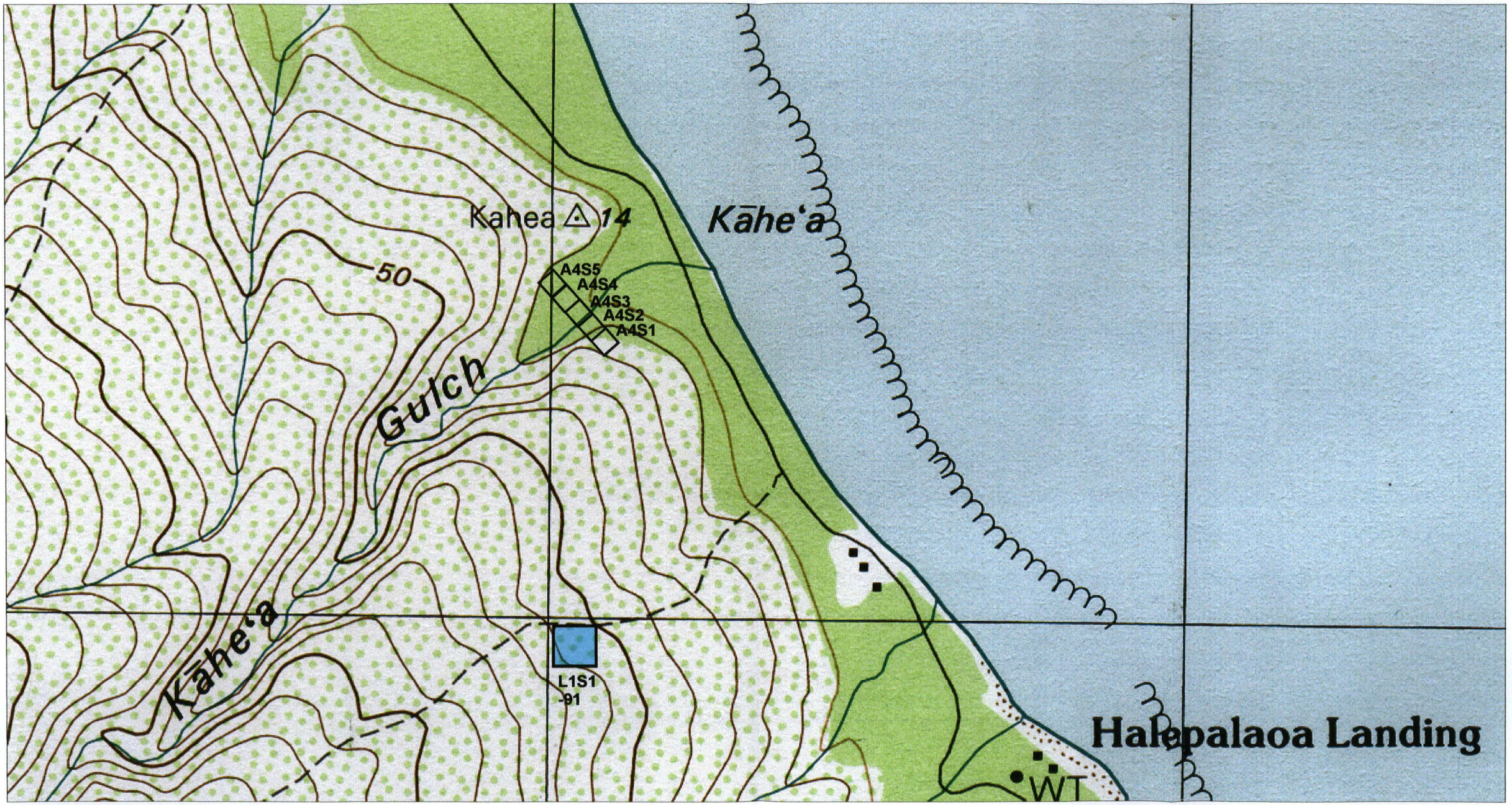
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 3
Maunalei Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-7

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area3.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N W E S

0 500 1000 1500
Scale in Feet

Explanation

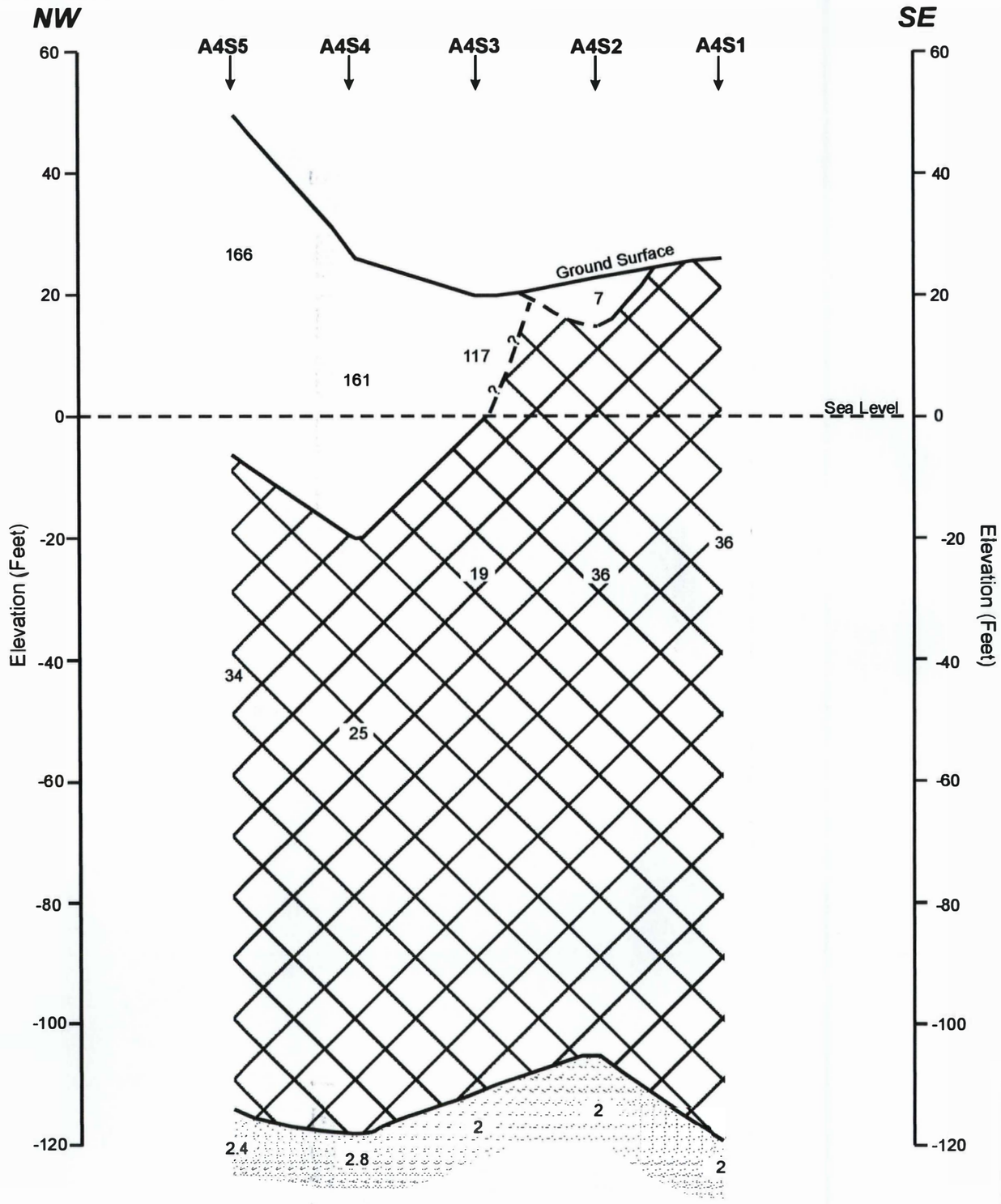
A4S1 ☐ August 2001 Transmitter Loops

Area 4
Detailed (EM47) Sounding Location Map
Club Lanai/Kāhea Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-8

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area4.cdr



Explanation

53 Resistivity in ohm-m

Laterite Soil

Dry Unweathered or Fresh-Brackish Water Saturated Volcanics

Inferred Structure (Possible Ash Flows, Weathered Volcanics or Intrusives

Salt Water Saturated Volcanics

Weathered Volcanics or Sea Water Mixing Below Sea Level

Inferred Geologic/Hydrologic Discontinuity

20' Scale in Feet

100'

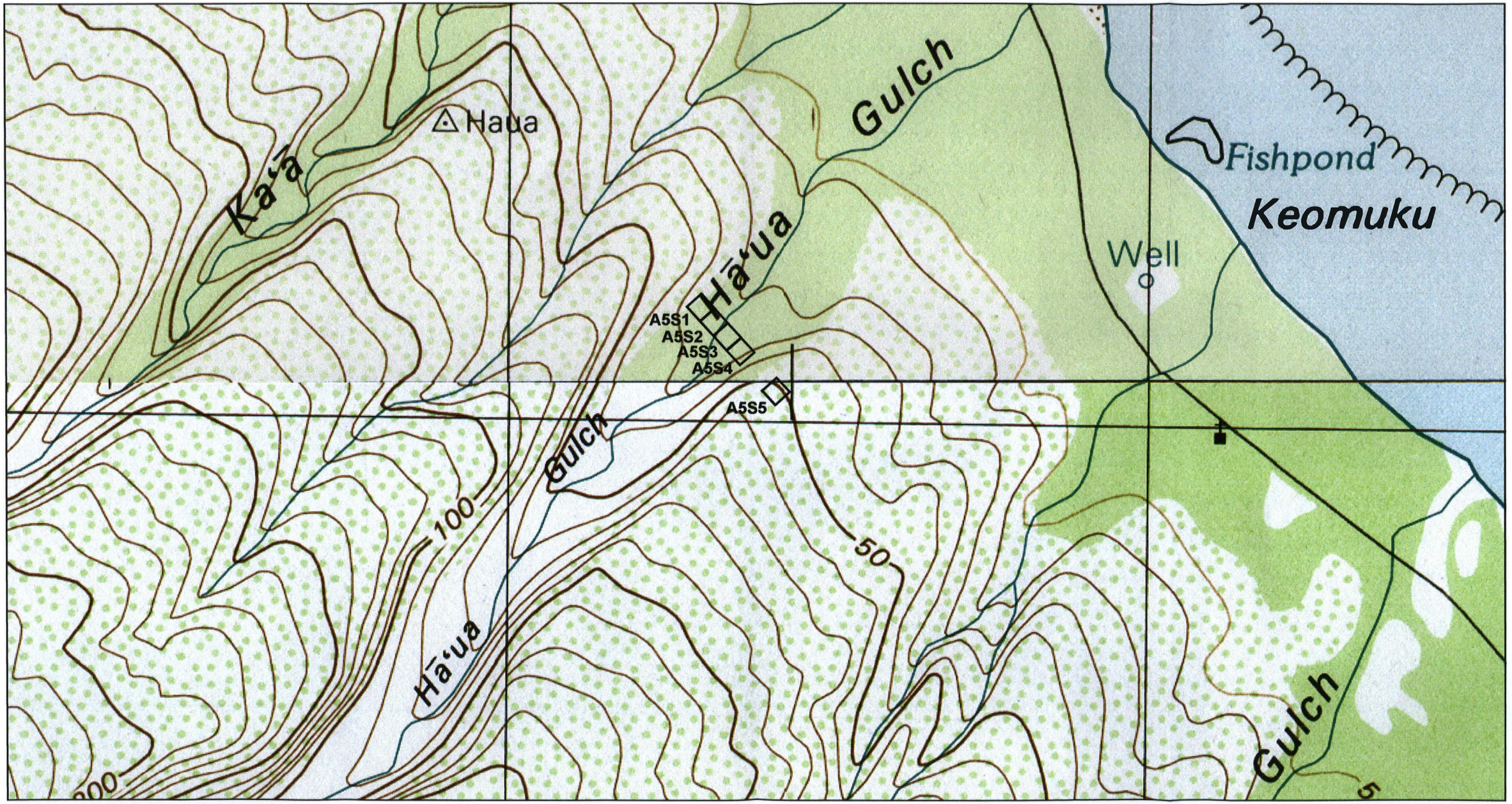
BLACKHAWK GeoSciences a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 4
Club Lanai/Kahea Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-9

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area7.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

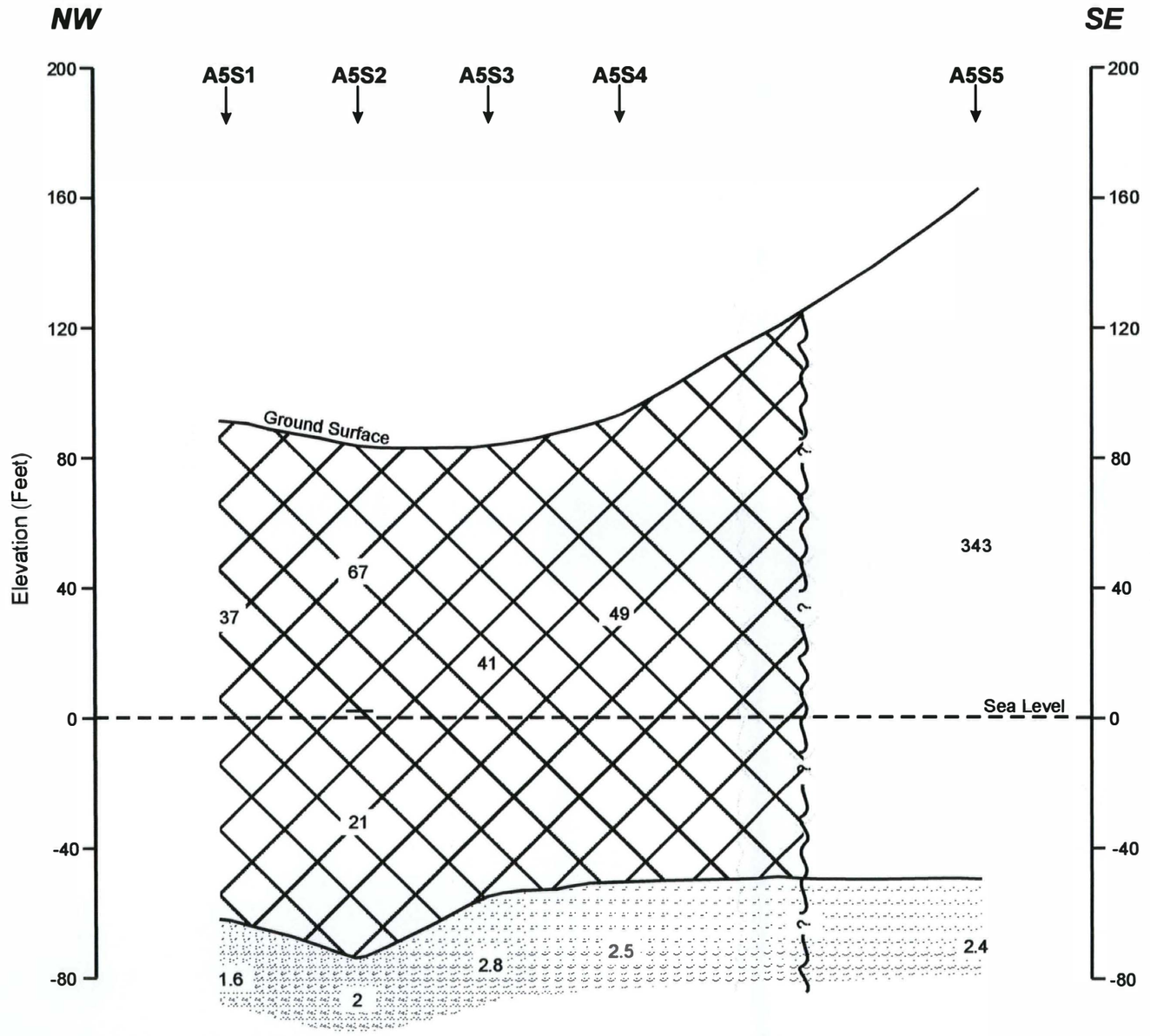
A5S1 August 2001 Transmitter Loops

Area 5
Detailed (EM47) Sounding Location Map
Haua Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-10

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area5.cdr



Explanation

53 Resistivity in ohm-m

Laterite Soil

Dry Unweathered or Fresh-Brackish Water Saturated Volcanics

Inferred Structure (Possible Ash Flows, Weathered Volcanics or Intrusives

Salt Water Saturated Volcanics

Weathered Volcanics or Sea Water Mixing Below Sea Level

Inferred Geologic/Hydrologic Discontinuity

40' Scale in Feet

100'

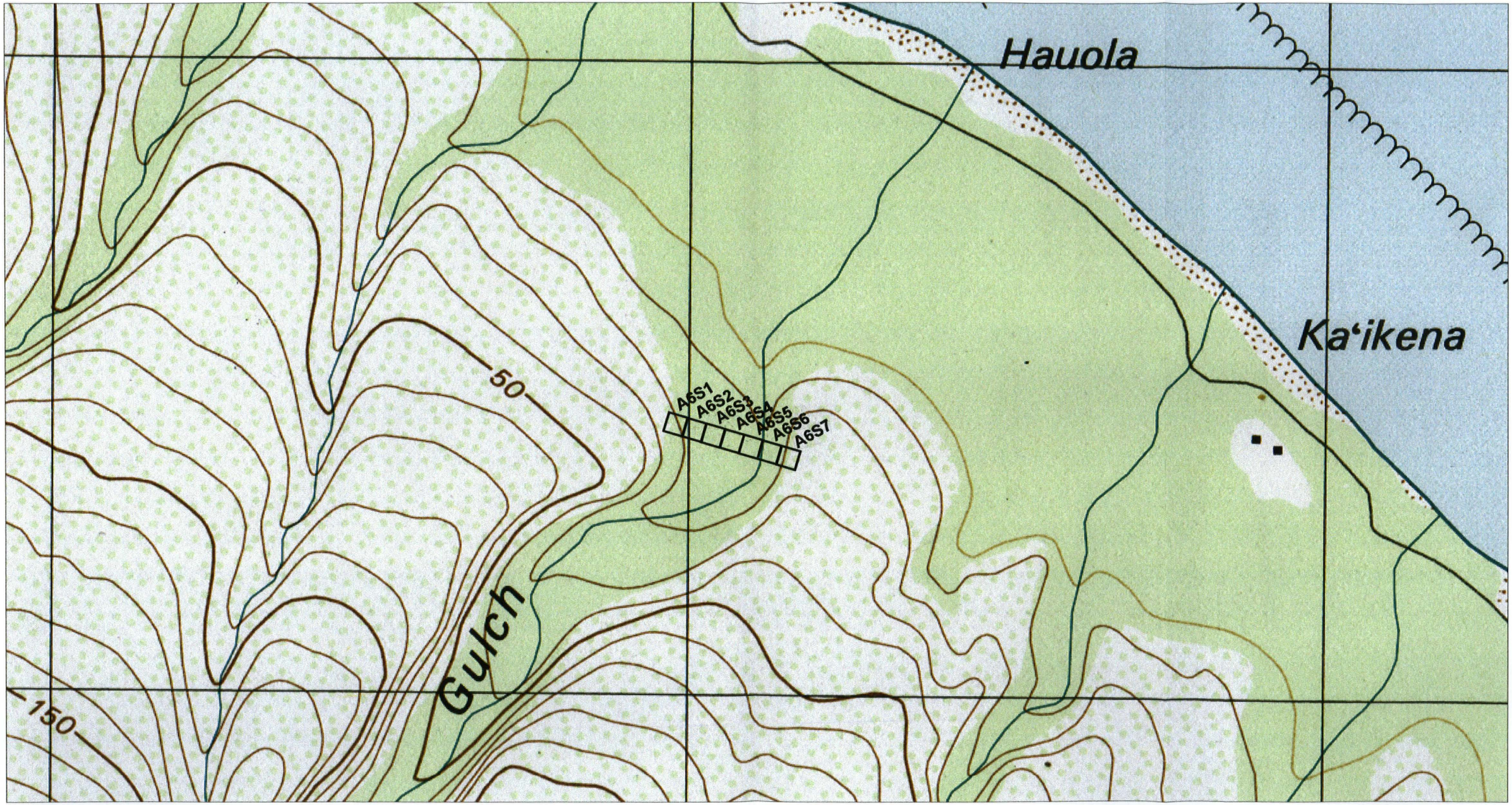
BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

Geoelectric
Cross Section Area 5
Haua Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-11

Project No: 2144LWC

\Projects\2144lwc\Geo_Xsec_Area5.cdr



BLACKHAWK GeoSciences
a division of Blackhawk GeoServices

N
W E
S

0 500 1000 1500
Scale in Feet

Explanation

A6S1 August 2001 Transmitter Loops

Area 6
Detailed (EM47) Sounding Location Map
Hauola Gulch, Lanai, Hawaii
Lanai Water Company, Inc

Figure No: 6-12

Project No: 2144LWC

\Projects\2144lwc\Lanai_Area6.cdr

MAP GOES HERE

WELL_NO	WELL_NAME	Year	DRILLER	Type	Diam	Elev	Depth	Solid	PERF	SWL	Chlor	TEST_DATE	GPM	Drwdn	Chlor	PUMP_
4552-01	Lanai 12	1990	FRANSEN DRLG	PER	12	605	630	600	620	5.0		11/27/1990	160	8.2	708	100
4553-01	Lanai 13	1990	FRANSEN DRLG	PER	12	695	750	680	700				12	12.0		
4555-01	Lanai 10	1989	WAT RES INTL	ROT		1228	1020			206.5	330					300
4852-01	Mtn House Tunnel	1918	J H FOSS	TUN		2700										
4852-02	Lanai 5	1950	CAMAY DRLG CO		18	2296	1122	630	1120	1548.0						900
4853-01	Gay Tunnel	1920	CHAS GAY	TUN		1920										
4853-02	Well 1	1945	CAMAY DRLG CO		12	1265	1274			876.0			300	45.0		700
4854-01	Lanai 9	1990	WAT RES INTL	ROT	14	1411	1451	510	766	803.0		7/20/1990	336	105.1		300
4854-02	Lanai 14	1995	RAINBOW DRLG	ROT	14	1194	950	650	950		700	12/15/2003	300	32.7	710	350
4952-01	Waiapaa Tun	1924		TUN		2220										
4952-02	Well 4	1950	CAMAY DRLG CO		18	2327	1178	669	1170	1576.0			660	16.0		900
4953-01	Well 2	1946	CAMAY DRLG CO		18	1510	609									1400
4953-02	Shaft 3	1954		SHF												
4954-01	Lanai 3	1950	CAMAY DRLG CO		18	1850	1199	442	1189	1078.0						300
4954-02	Lanai 8	1990	WAT RES INTL	ROT	14	1902	1490	942	1485	1014.0		6/11/1990	1110	37.9	40	800
5053-01	Maunalei Tun 1	1911	W O CLARK	TUN		1103				1103.0						
5053-02	Maunalei Tun 2	1911		TUN		1500				1500.0						
5054-01	Kaiholena TH-3	1950	MULLIN							1064.0						
5054-02	Well 6	1986	ROSCOE MOSS	PER	16	1910	1310	1110	1310	1005.0			30	50.0	23	550
5055-01	Lanai 7	1987	ROSCOE MOSS	PER	8	2100	1650				67					500
5149-01	Gay Well A	1900		PER	6	16	60			2.0			400		821	
5154-01	Maunalei Shft 2	1936		TUN		851	372			739.0	31		20	2.0		
5253-01	Maunalei Shft 1	1936	W O CLARK	TUN		294	293			2.4	374					

93.02

WINDWARD COAST PROJECT AREA

NORTHWEST RIFT PROJECT AREA

TREND OF NORTHWEST RIFT ZONE

NWRZ5

NWRZ4

NWRZ1

NWRZ2

NWRZ3

LINE 5

LINE 2

LINE 3

LINE 4

LINE 1

L1S1

L1S2

L2S3

L3S1

L3S2

L4S1

L4S2

L5S1

L5S2

L6S1

L6S2

L7S1

L7S2

L8S1

L8S2

L9S1

L9S2

L10S1

L10S2

L11S1

L11S2

L12S1

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L13S1

L13S2

L14S1

L14S2

L15S1

L15S2

L16S1

L16S2

L17S1

L17S2

L18S1

L18S2

L19S1

L19S2

L20S1

L20S2

L21S1

L21S2

L22S1

L22S2

LANAI NORTH, HAWAII
MAUI COUNTY

KALOHI CHANNEL

AUAU CHANNEL

PACIFIC OCEAN

APPROXIMATE LOCATION OF INTERPRETED GEOLOGIC STRUCTURE (RIFT ZONE)

TREND OF NORTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTH RIFT ZONE

Area 1

Area 2

Area 3

Area 4

Area 5

Area 6

Area 7

Revised Location of Damming Structure

Original Location of Damming Structure

A1S5 (2001)

A1S3 (2001)

A1S2 (2001)

A1S4 (2001)

A2S1

A' B' C' D' E' F' G' H'

Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

? Revised Location of Damming Structure

A1S3 August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

LC50 August 1994 transmitter loop and number includes: PB#, L#, S# and NWRZ# October-November 1994 transmitter loop and number denoted by LC#

1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

N

0 4000 8000 12,000

Scale in Feet

Blackhawk GeoSciences
Golden, Colorado

Geophysical Interpretation TDEM Sounding Summary Map

Island of Lanai, Hawaii

Lanai Water Company, Inc.

Figure No. 7-1

Project No. 2144LWC

File No. I:\projects\2144lwc\Lanai_Base_All_Interp.cdr

Date: Aug. 2001

Prepared for Hawaii

LANAI NORTH, HAWAII
MAUI COUNTY

KALOHI CHANNEL

AUAU CHANNEL

PACIFIC OCEAN

A' B' H' C' D' E' F' G' A B C D E F G H

Area 1 Area 2 Area 3 Area 4 Area 5 Area 6 Area 7

TREND OF NORTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTH RIFT ZONE

LAHAINA

Explanation

-40 Approximate Elevation of Top of Salt Water Interface in Feet

A1S3 August 2001 Transmitter Loops

Sounding in which ground water is expected in the Basal Mode

Sounding interpreted to be located within the ground water barrier (Zone of change) Data may be distorted by 2-dimensional geoelectric structures

Sounding in which ground water is expected to be controlled by geologic structure (Potential high-level water)

? Inferred geologic/hydrologic discontinuity (Position and width ? uncertain)

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1993 data loop location

Well 10 (210') Well number with head in feet (Color represents type of ground water occurrence: Blue = Basal Yellow = High Level)

Brackish water pipeline (Metal)

Irrigation pipeline (Metal)

A A' Geoelectric Cross Section

61.2" @ 1" = 4000'
⇒ 46± miles
13 NWRZ / 46 = 0.3 NWRZ / mile

N

0 4000 8000 12,000
Scale in Feet

Blackhawk GeoSciences
Golden, Colorado

TDEM Sounding Location Map

Island of Lanai, Hawaii

Lanai Water Company, Inc.

Figure No.	2-1
Project No.	2144LWC
File No.	projects\2144lwc\Lanai_Base_All.cdr
Date:	Aug. 2001

Proposed THREE

TOPOGRAPHIC MAP

OF THE

OF LANAI

UNTY, HAWAII

AROLD T. STEARNS, 1936

I COOPERATION WITH THE

S GEOLOGICAL SURVEY

S 1/35500

2 3 4 Miles

10000 15000 20000 Feet

2 3 4 5 Kilometers

ur interval 50 feet.

n is mean sea level.

PROBABLY PLIOCENE AND EARLY PLEISTOCENE

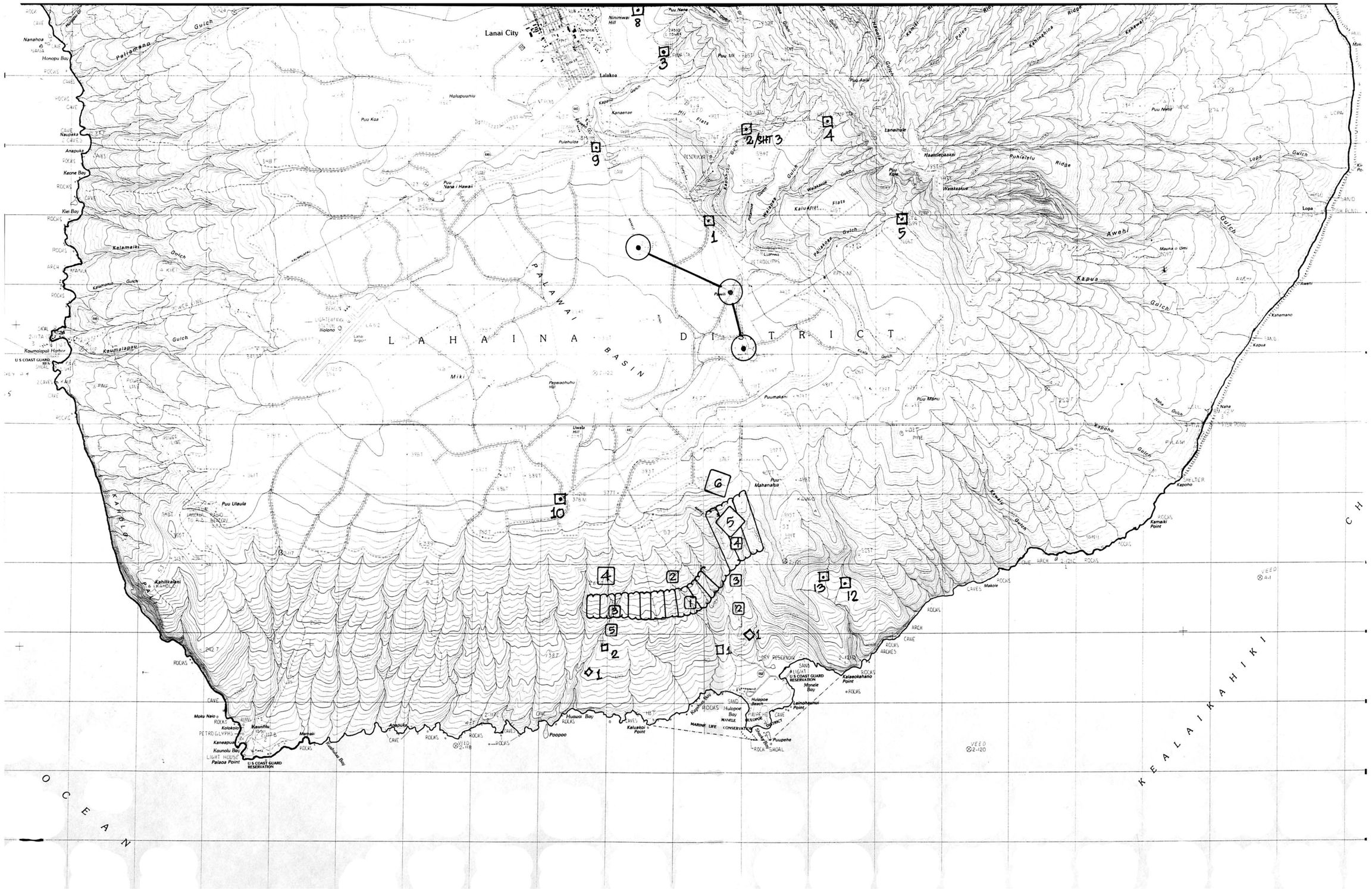
(*Essentially contemporaneous*)

TRUE NORTH

MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1930

157°00′ 55′ 50′ 45′ 20° 50′


Lanai City
Lalakoa
Ninimwai Hill
Puu Nana
Puu Alii
Puu Nanii
Puu Koa
Hulupuuniu
Kanaenae
Pulehuloa
Puu Nana i Hawaii
Lanaihale
Puu Kole
Puhielelu Ridge
Waakeakua
Kaluanui Flats
Palaeaea Gulch
Waiapa Gulch
Waiahuli Gulch
Kaeo Gulch
Kaiakeakua Gulch
Lopa Gulch
Awehi Gulch
Kapua Gulch
Kahemano
Mauna o Umi
Nana
Kapoho Gulch
Kawaiu Gulch
Nuu Gulch
Kamaiki Point
Kapoho
SHELTER
Makole
Puu Mahanaiu
Puu Ulaula
Uwala Hill
Pepeaohuhu Hill
Puumakani
Puu Ktanu
Miki
Ilioiono
Lanai Airport
Nanahoa
Honopu Bay
Naupaka Caves
Anapuka
Keone Bay
Kiei Bay
Kalamaiki Gulch
Kaumalapau
Kaumalapau Harbor
U S COAST GUARD RES.
Kahilikalani
Moku Naio
Kolokolo
Kaunolu
Kaneapua
Kaunolu Bay
Palaoa Point
U S COAST GUARD RESERVATION
Manai
Kaiakahinali Gulch
Kaiakahinali Bay
Hulopoe Bay
Hulopoe Beach
Manele Bay
Manele
Hulopoe
Marine Life Conservation District
Kaluakoi Point
Poopoo
Puupehe
Shipwreck Beach
Kaleaokahano Point
Loinohaumui Point
Kapihaa Bay
Hulaa Bay
Awehi
Lopa
Kahemano
Kapua
Nana
Kapoho
Kamaiki Point
Makole
Kahilikalani
Puu Ulaula
Puu Mahanaiu
Kaiakahinali Gulch
Kaiakahinali Bay
Kaiakeakua Gulch
Kaeo Gulch
Waiapa Gulch
Waiahuli Gulch
Palaeaea Gulch
Kaluanui Flats
Puhielelu Ridge
Lopa Gulch
Awehi Gulch
Kapua Gulch
Kawaiu Gulch
Nuu Gulch
Kapoho Gulch
Kaumalapau Gulch
Kalamaiki Gulch
Pelaeaea Gulch
Kanaenae Gulch
Kaeo Gulch
Waiapa Gulch
Waiahuli Gulch
Kaiakeakua Gulch

LANAI NORTH, HAWAII
MAUI COUNTY

KALOHI CHANNEL

PACIFIC OCEAN

AUAU CHANNEL

LAHAINA

TREND OF NORTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTHWEST RIFT ZONE

APPROXIMATE LOCATION OF SOUTH RIFT ZONE

A' B' H' C' D' E' F' G'

A B C D E F G H

LEGEND

-40 APPROXIMATE ELEVATION OF TOP OF SALT WATER INTERFACE IN FEET

SOUNDING IN WHICH GROUND WATER IS EXPECTED IN THE BASAL MODE

SOUNDING INTERPRETED TO BE LOCATED WITHIN THE GROUND WATER BARRIER (ZONE OF CHANGE)

SOUNDING IN WHICH GROUND WATER IS EXPECTED TO BE CONTROLLED BY GEOLOGIC STRUCTURE (POTENTIAL HIGH-LEVEL WATER)

INFERRED GEOLOGIC/HYDROLOGIC DISCONTINUITY (POSITION AND WIDTH UNCERTAIN) TDEM SOUNDING MAY BE DISTORTED BY 2-DIMENSIONAL GEOELECTRIC STRUCTURES

LC50 AUGUST 1994 TRANSMITTER LOOP AND NUMBER INCLUDES: PB#, L#S# AND NWRZ#

OCTOBER - NOVEMBER 1994 TRANSMITTER LOOP AND NUMBER DENOTED BY LC#

1993 DATA LOOP LOCATION

WELL 10 (2107) WELL NUMBER WITH HEAD IN FEET

BRACKISH WATER PIPELINE (METAL)

IRRIGATION PIPELINE (METAL)

A A' GEOELECTRIC CROSS SECTION

N

DECLINATION 11.5° EAST

SCALE IN METERS 0 1000 2000 3000 4000 5000

CONTOUR INTERVAL 10 METERS
SUPPLEMENTARY CONTOUR INTERVAL 5 METERS

SCALE IN FEET 0 2000 4000 6000 8000 10000 12000 14000 16000

CEES BLACKHAWK GEOSCIENCES DIVISION

GEOPHYSICAL INTERPRETATION TDEM SOUNDING SUMMARY MAP

LANAI WATER COMPANY, INC.
ISLAND OF LANAI, HAWAII

PROJECT NO: 9081-000

LANAI SOUTH, HAWAII
PROVISIONAL EDITION 1994
20154-F7-TM-025

BLACKHAWK
GEOMETRICS

Surface Geophysics - A Tool for Ground Water Management in Coastal Aquifers

Introduction

Protection and proper management of ground water resources is an ongoing challenge particularly for coastal aquifers where salt water encroachment in fresh water aquifers can be an immediate result of over-withdrawal. Technologies for regional evaluation and assessment of ground water resources, such as remote sensing and computer simulation of ground water flow, have advanced significantly in the last two decades. Surface geophysics is another tool for ground water investigations that has seen major advancements, and such methods are used for mapping objectives at depths beyond the reach of remote sensing methods, such as visible, infrared or microwave imaging.

Geophysical techniques are similar to remote sensing in that information about physical properties of the subsurface are inferred "remotely" from measurements made at the surface. The basis of these geophysical techniques is that different geologic formations often have different characteristic ranges of physical properties, and subsurface geological structures and water quality can be inferred from the lateral and vertical variations in physical properties.

Description of Method

A physical property often exploited in ground water investigations is electrical resistivity because it is the only physical property dependent on the concentration of dissolved solids (salts) in ground water. The difference in resistivity between aquifers saturated with fresh water and salt water is considerable. Also, there is a strong relationship between electrical resistivity and clay content. Clay content often is a major factor determining hydraulic permeability of soils and rocks.

The ground water industry has employed surface electrical geophysical techniques for more than six decades. Techniques with improved lateral and vertical resolution have partially replaced older methods in the last ten years. One of these new techniques is called time domain electromagnetic (TDEM) soundings, and it is particularly well suited for assisting in mapping boundaries between fresh water and salt water in coastal aquifers.

TDEM Principles

All electrical and electromagnetic geophysical techniques have one important principle in common - electrical resistivity is derived from measuring the resistance of the earth to flow of electrical current. Thus, electrical current flow must be generated in the ground, and that is done by magnetic induction in the TDEM method. A square wave current is driven through a transmitter consisting of square loops of small diameter insulated wire laid on the ground surface (Figure 1). The dimensions of these loops are varied depending on required exploration depth. Smaller dimensions are used for shallower depths. The square wave current driven through the transmitter causes a time-varying magnetic field. This "primary" magnetic field in turn induces eddy current flow in the ground (Faraday's Law), and the intensity of these eddy currents is a function of the electrical resistivity stratification in the subsurface.

In horizontally layered ground, the eddy currents are horizontally closed rings concentric about the transmitter loop. Immediately after current turn-off in the transmitter, the ground eddy currents are concentrated near the surface, and with increasing time eddy currents are progressively induced at greater depth. A small receiver coil in the center of the transmitter loop measures the voltage due to the secondary magnetic field caused by the eddy currents. From the time-decay of the voltage the resistivity layering in the ground is computed.

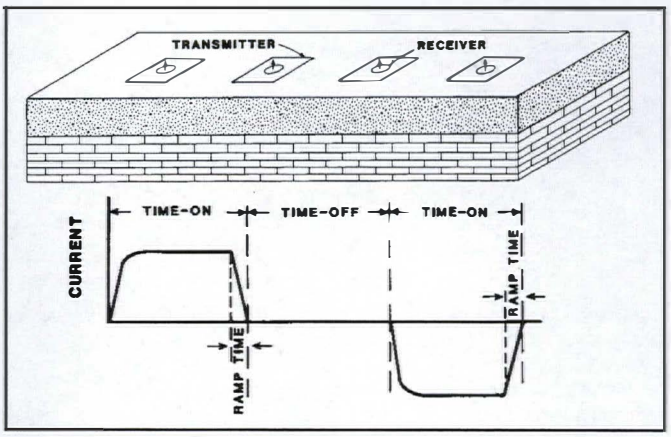


Fig. 1 The transmitter used in TDEM is made of square loops of insulated wire. A receiver measures the electromagnetic field in the center. The current waveform driven through the transmitter is a half-duty cycle.

Surface Geophysics Applied to Coastal Aquifers

The role of surface geophysics for evaluating ground water resources, and the threat to such resources by salt water encroachment, is illustrated by case histories for four areas - New York, California, Hawaii and Florida.

New York

Long Island, New York is 118 miles long and its widest part is about 22 miles. It is bordered on the north by the Long Island Sound and on the south by the Atlantic Ocean (Figure 2). The 2.6 million people of Long Island depend entirely on fresh water drawn from underground aquifers. The island was among the first areas designated as a sole source aquifer by the United States Environmental Protection Agency under the Safe Drinking Water Act.

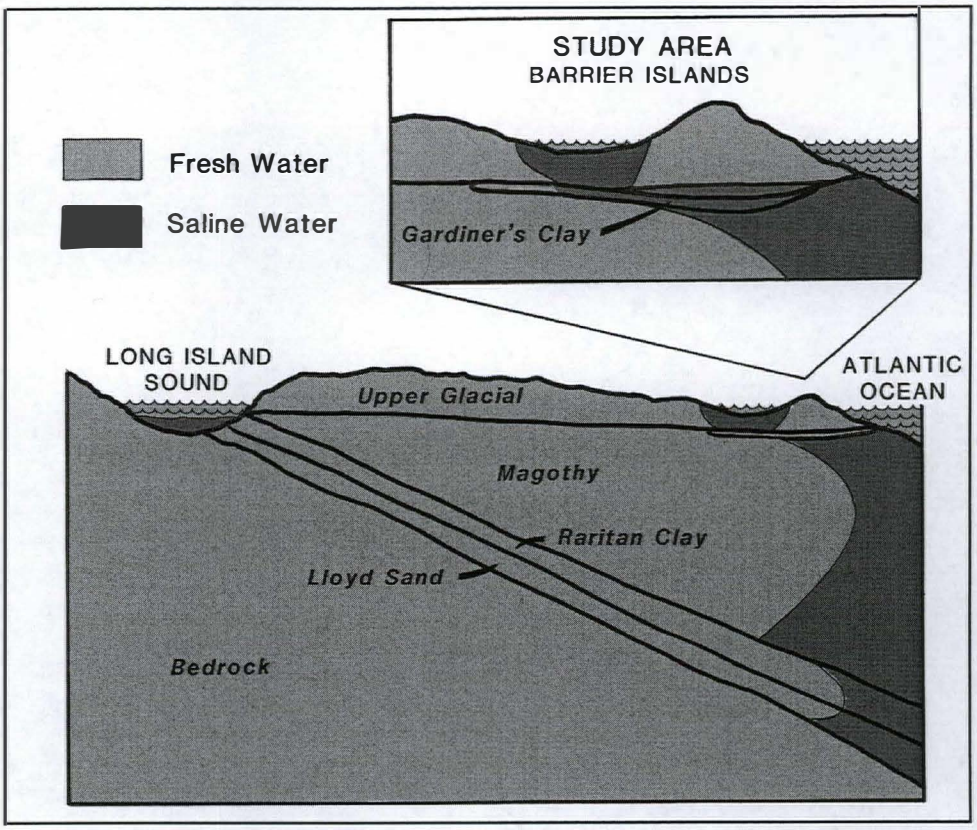


Fig. 2 A schematic north-south cross section of Long Island, New York, USA, illustrates the island's geographic position between the Atlantic Ocean and the Long Island Sound.

The Magothy aquifer is the most important aquifer for water supply on Long Island, ranging from 0 ft. thick on the north shore to about 1000 ft. thick on the south shore. There are two major areas where salt water can enter the Magothy; on the south side where the Magothy sands outcrop below the Atlantic Ocean, and in the tidal flats behind the barrier islands. Salt water could potentially enter the main aquifer vertically in the tidal flats. However, there is a clay layer (strata of low permeability) above the Magothy aquifer beneath this vulnerable area.

Salt water intrusion is a concern at present levels of pumpage which could threaten some of the southern-most wells in Nassau County. Studies have been ongoing since the 1950s to monitor the salt water interface in wells, but no evidence of inland progression of salt water into the Magothy Aquifer has been observed between the 1950s and the present. In 1988, Nassau County officials decided to explore geophysical methods of data gathering information, in addition to placing monitoring wells to obtain more information on the regional continuity of the fresh water - salt water boundary, and the clay layer beneath the tidal flats.

Two hydrogeologic cross-sections derived from the TDEM survey in the tidal flats behind the barrier islands are shown in Figures 3a and 3b. The cross sections show an interpretation of the resistivity values in terms of water quality. Such an interpretation scheme is derived from correlating electrical resistivity values from TDEM measurements near wells with water quality from well samples.

The cross-section shown in Figure 3a runs from the tidal flats north onto the barrier islands. Below the barrier island, a lens of fresh water is observed above a saline water wedge. Over the tidal flats, the upper glacial sediments are saturated with saline water, but this upper zone is shallow because the clay layer retards vertical migration of salt water into the aquifer.

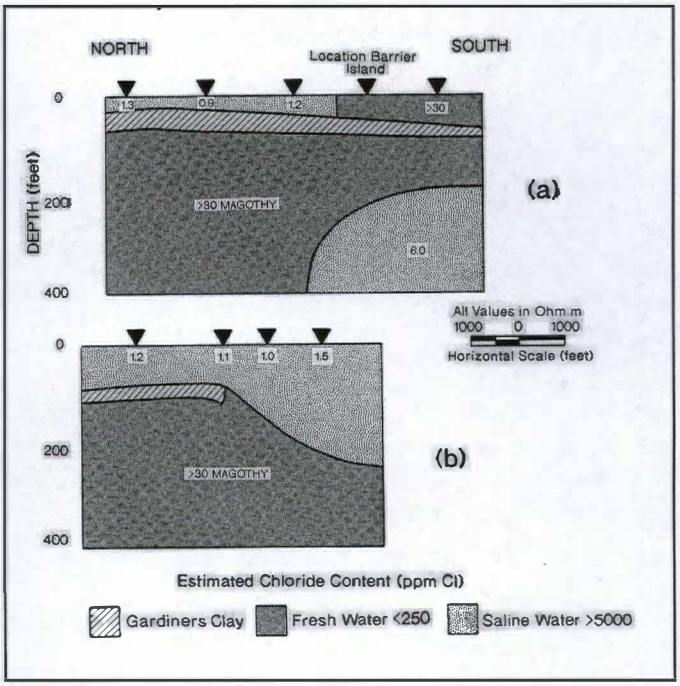


Fig. 3 TDEM-derived hydrogeologic cross-sections in the tidal flats behind the barrier islands on Long Island, New York, provides a glimpse at the areas where the aquifer is most vulnerable.

The cross-section shown in Figure 3b extends into an area of the tidal flats where the clay layer is eroded, and now saline water has migrated to depths in excess of 200 ft. into the Magothy aquifer. Surface geophysics has provided critically required water quality data between wells and mapped areas where the aquifer is most vulnerable to salt water intrusion.

Salinas Valley, California

The Salinas Valley is a large intermontane valley extending approximately 120 miles southward from Monterey Bay. The Salinas River meanders through the valley and is bordered on the west by the Sierra de Salinas, and on the northeast and southwest by the Diablo Range. On the northern end of the Salinas Valley, where the river discharges into Monterey Bay, three major confining zones separate the alluvial fill into four predominant aquifers (Figure 4) - the perched, the "180 ft." , the "400 ft.", and the "900 ft." aquifers. The perched and the "900 ft." aquifers are not utilized at this time.

Recharge of these aquifers occurs primarily in the Forebay area, an unconfined ground water zone located 20 to 45 miles inland from the coast. During the dry months, low or non-existent flows in the Salinas River are augmented by scheduled release of water from two upstream reservoirs.

Sea-water intrusion in the Salinas Valley coastal aquifers was first recognized in the mid 1930s. Since then saline water has spread into the ground water aquifers beneath thousands of acres of prime agricultural land. The economic threat to agriculture and municipalities in the intrusion area has worsened as solutions to combat this are being studied. Many water wells in the vicinity of the study area are monitored on a regular basis. While the landward extent of sea-water intrusion has been generally well-defined, stratigraphy and salinity information needed to be interpolated between widely spaced monitoring wells.

Relying solely on wells to monitor the movement of fresh water/salt water interfaces has certain drawbacks. Once a salt water boundary has migrated inland beyond a well, the utility of the well to add further information about the boundary diminishes. Moreover, fresh water/salt water interfaces can be irregular due to higher permeabilities of certain sections of the aquifer. In 1986, local water authorities decided to conduct surface geophysical surveys to assist in defining the extent of salt water encroachment in the aquifers of the Salinas Valley.

The surface projection of the 500ppm isochlor in the "180 ft." and "400 ft." aquifers derived from monitoring wells was compared with the 500ppm isochlor derived from about 100 TDEM stations. As in the previous case history, the correlation between TDEM resistivity and salinity was made using TDEM soundings near monitoring wells.

In this case, salinity information was obtained in the "400 ft." aquifer underneath the highly conductive sea water intruded "180 ft." aquifer. The higher density of TDEM soundings when compared to monitoring wells allowed a more accurate positioning of the 500ppm isochlor in both the "180 ft." and "400 ft." aquifers. This increase in accuracy will benefit water management decisions, and assist in placing future monitoring wells.

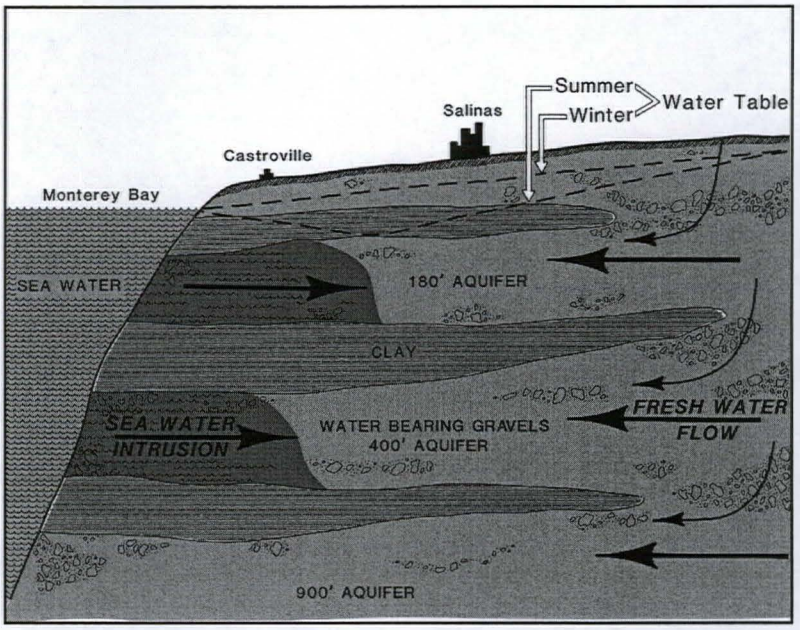


Fig. 4 A hydrogeologic cross-section illustrates where the Salinas Valley enters into Monterey Bay.

Hawaiian Islands

The Hawaiian Islands have been formed by lava flows emanating from volcanos which are still active today. The lava flows are often highly permeable and are excellent aquifers where they are saturated with fresh water. Because of the highly permeable rock, very few sites in Hawaii are suitable for the construction of impounding reservoirs, and the increasing demand of water supplies for resource development will need to be satisfied by ground water supplies. This will not only be true for the Hawaiian Islands but other volcanic and coralline islands throughout the Pacific and in the Caribbean as well.

Rainfall in Hawaii is unevenly distributed and concentrated mainly on the east sides where moist Pacific air rises onto the volcanic peaks. Rainfall rapidly enters the porous volcanic rocks in most locations and infiltrates to the ground water table and eventually discharges into the ocean. Above the rift zones, dikes of intrusive rock which originate from magma sources below have cut the volcanic rock (Figure 5). These dikes form natural ground water dams. Fresh water head differences as high as 1000 ft. occur across these natural dams, and horizontal tunnels have been bored into these dike-confined compartments, providing important sources of ground water.

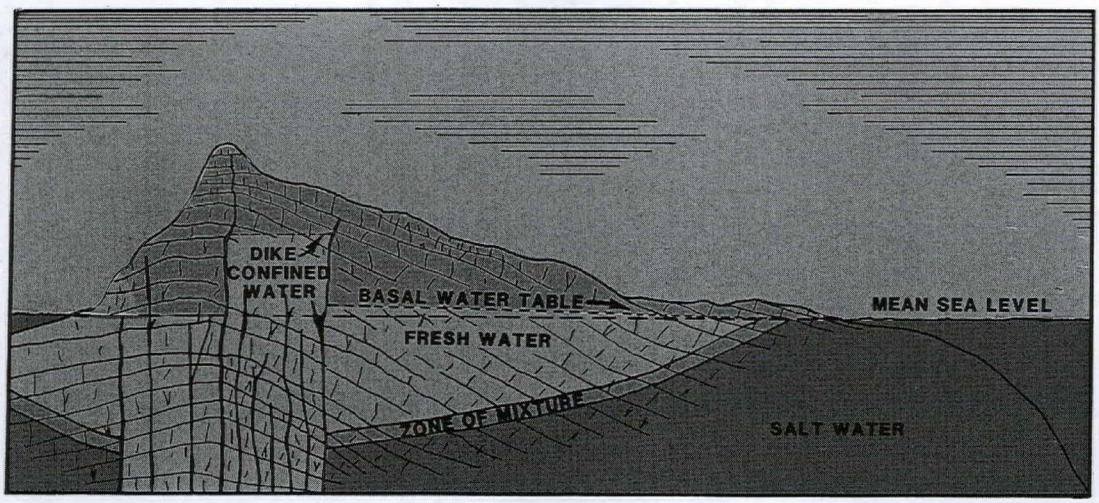


Fig. 5 A typical hydrogeologic cross-section of volcanic islands shows the dike that can form natural ground water dams.

Another important source is the basal fresh water lens. A delicate balance exists between fresh water recharge from rainfall and salt water encroachment. Because of the density difference between salt water (1.025 gm/cm^3) and fresh water (1gm/cm^3), there will be 40 ft. of fresh water below sea level for every foot of fresh water head above sea level. The thickest lens of fresh water will be found inland near the source of recharge where the drilling depth to fresh water can readily exceed 1000 ft. Hydrogeologists in Hawaii are increasingly using geophysical surveys to map the fresh water lens beneath lava flows with thicknesses over 1000 ft.

Geophysics was used to evaluate ground water resources on the island of Hawaii in an approximate 30 square mile area near Waikoloa Village. The cross-section in Figure 6, derived from TDEM measurements, illustrates that the drilling depth to the basal fresh water lens rapidly increases with elevation. The optimum drilling location is where the basal fresh water lens is the thickest and the drilling depth shallowest. Well drilling was necessary to determine yield and remove uncertainties and ambiguities inherent in geophysical interpretations. The geophysical survey indicated optimum sites for drilling, and provided regional data about water resources critical in managing well fields.

The Floridan Aquifer

The Floridan aquifer system is one of the most areally extensive and widely used sources of ground water supplies in the Southeastern United States. The Floridan underlies about 100,000 square miles, including all of Florida, south Georgia, southwest Alabama, and extreme south South Carolina. More than three billion gallons of water are pumped daily from the aquifer system, making it a major source of municipal, rural, industrial, and agricultural water supplies.

The fresh water resources in the Floridan are contained between the top of the Upper Floridan Aquifer and the interface between fresh water and brackish/saline water. The elevation of the fresh water-saline water interface can vary laterally over a few hundred feet, and the depth of the interface in the Floridan varies from a few hundred to several thousand feet. Mapping the interface has been the objective of a number of TDEM surveys in the St. Johns River Water Management District, the Southwest Florida Water Management District, and in Seminole County.

A critical component of surface geophysical surveys throughout Florida has been regional calibration of the depth of the fresh water-saline water interface derived

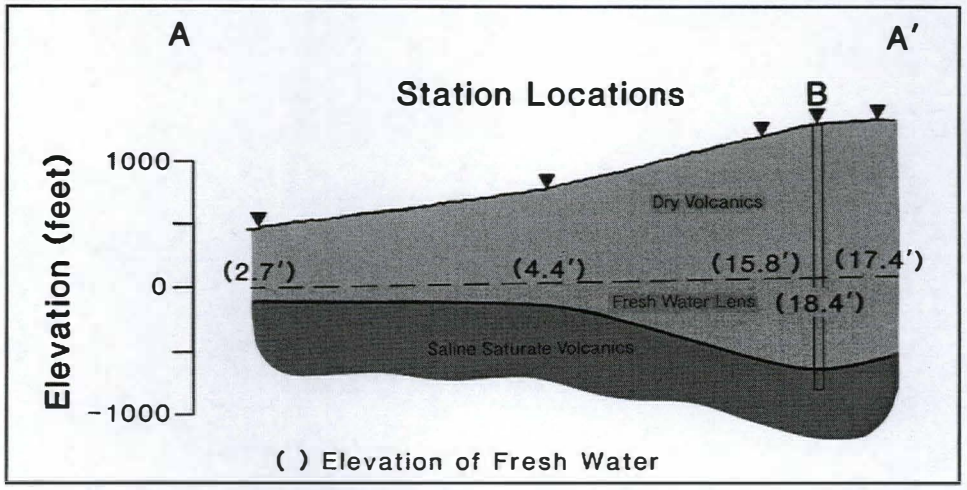


Fig. 6 Hydrogeologic cross-section derived from TDEM soundings illustrates that the drilling depth to the basal fresh water lens rapidly increases with elevation.

from TDEM soundings near monitoring wells, with water quality variation measured in the wells. Generally, there has been excellent agreement as illustrated in Figure 7.

The advantage of using geophysics is the low cost per station (less than $1,000) compared to tens of thousands for completing monitoring or production wells. TDEM soundings are, therefore, an excellent reconnaissance tool to optimally locate wells and plan the depth of completion. Also, the high station density that can be afforded can greatly increase the number of data calibration points for ground water modeling, increasing the accuracy of such modeling investigations.

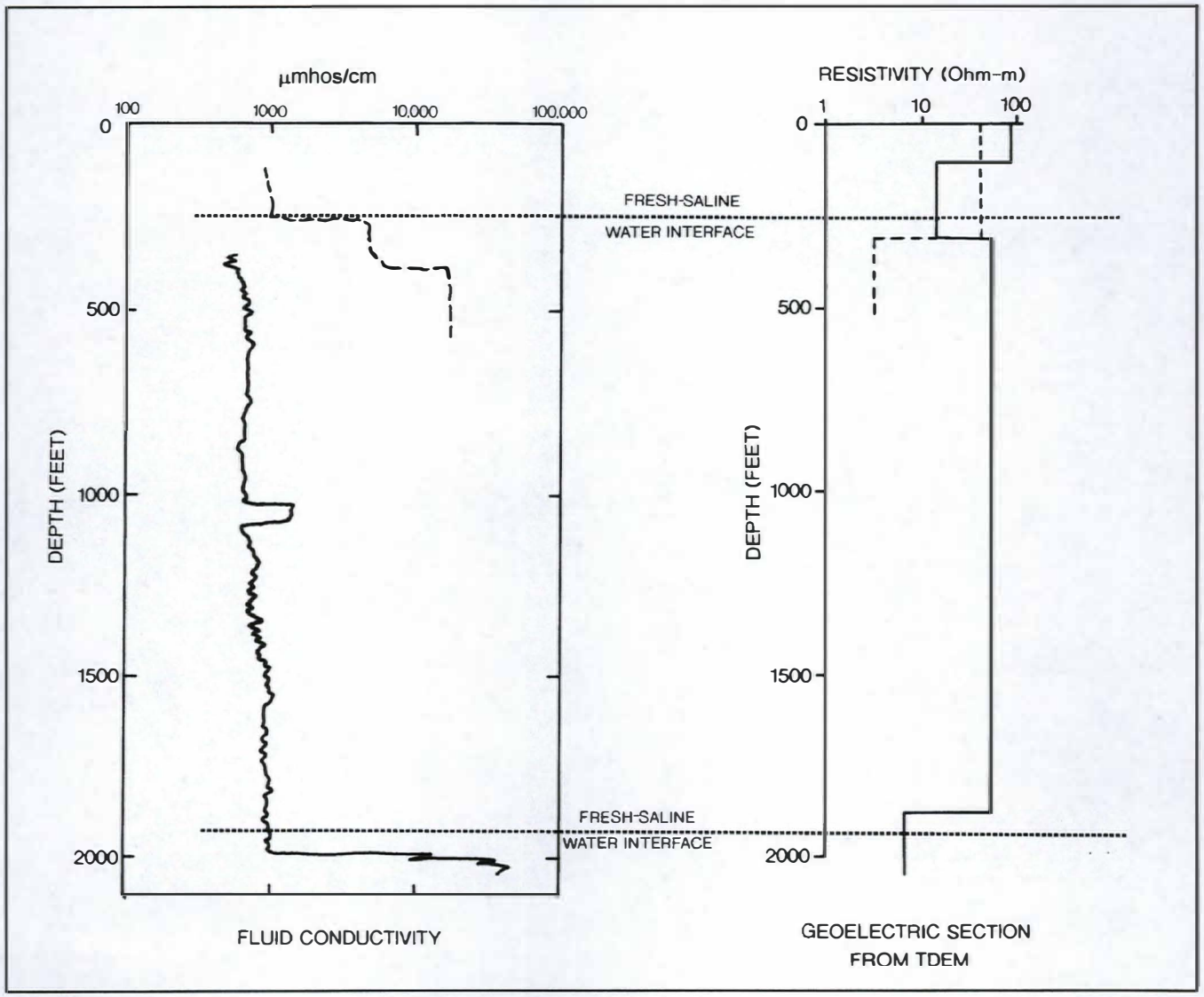


Fig. 7 Correlation between fluid resistivity and geoelectric section derived from TDEM soundings at two locations in the Floridan Aquifer; one where the fresh-saline water interface occurs at shallow depth and one where the interface is deep.

APPENDIX B-DATA PRINTOUTS
TIME DOMAIN ELECTROMAGNETIC SURVEYS FOR ASSISTING IN DETERMINING THE GROUNDWATER RESOURCES ON THE ISLAND OF LANAI, HAWAII

BLACKHAWK GEOSCIENCES PROJECT NUMBER 2144LWC

Prepared For:

LANAI WATER COMPANY, INC.
1223 Fraser Avenue, P.O. Box 310
Lanai City, Hawaii 96763
808-565-3856 • Fax 808-565-3881

Prepared By:

BLACKHAWK GEOSCIENCES, INC.
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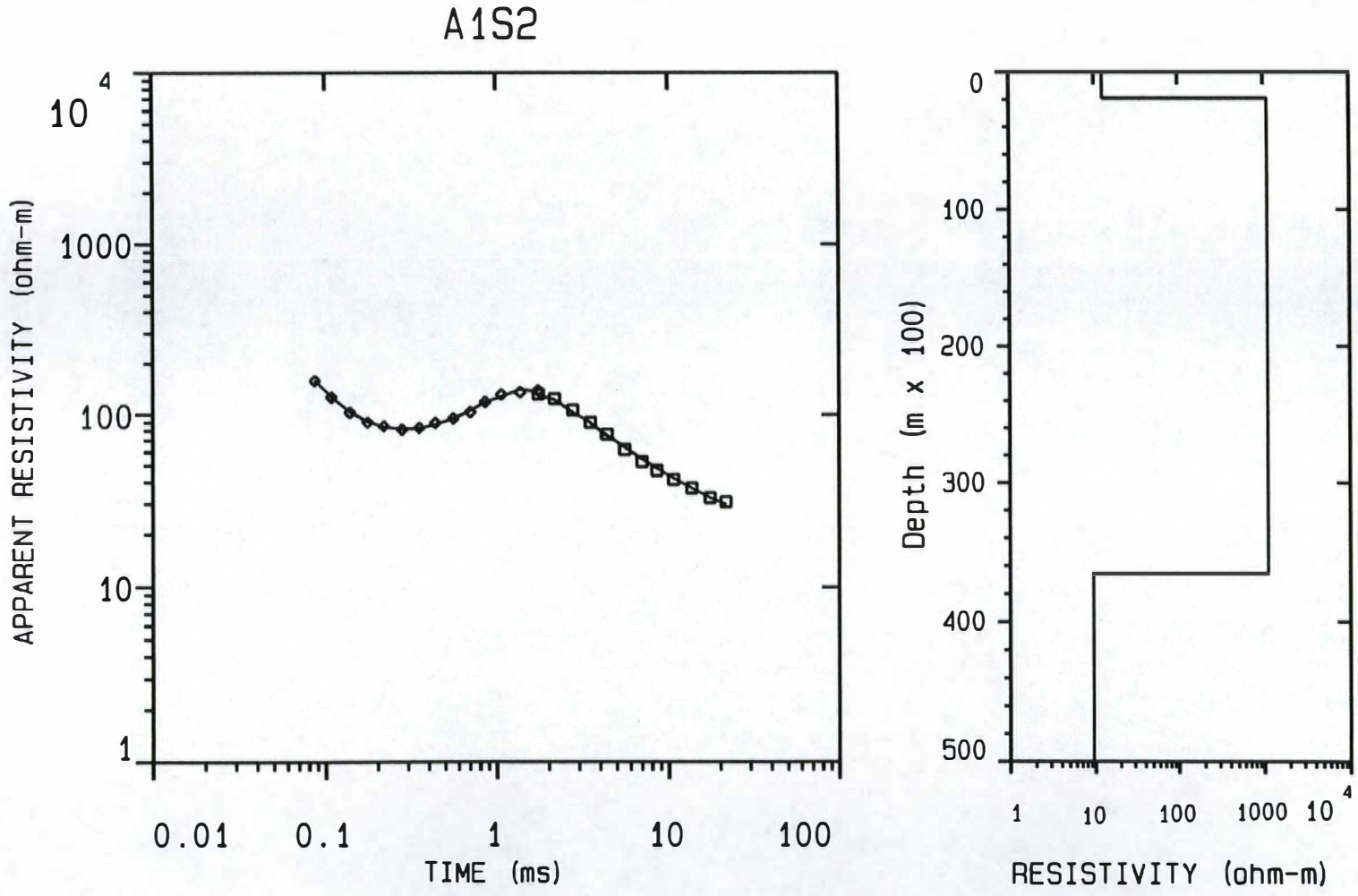
September 12, 2001


A1S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.01
0.1
1
10
100
TIME (ms)
Depth (m x 100)
0
100
200
300
400
500
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A1S2

CLIENT: Lanai Water Company DATE: 8-14-01
LOCATION: Area 1 SOUNDING: 1
COUNTY: Maui ELEVATION: 428.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 0.0000 N: 0.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.178 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			428.0	
1	12.49	18.90	409.0	1.51
2	1106.3	346.7	62.33	0.313
3	9.47			

ALL PARAMETERS ARE FREE

CURRENT: 16.80 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 182.00 muSEC

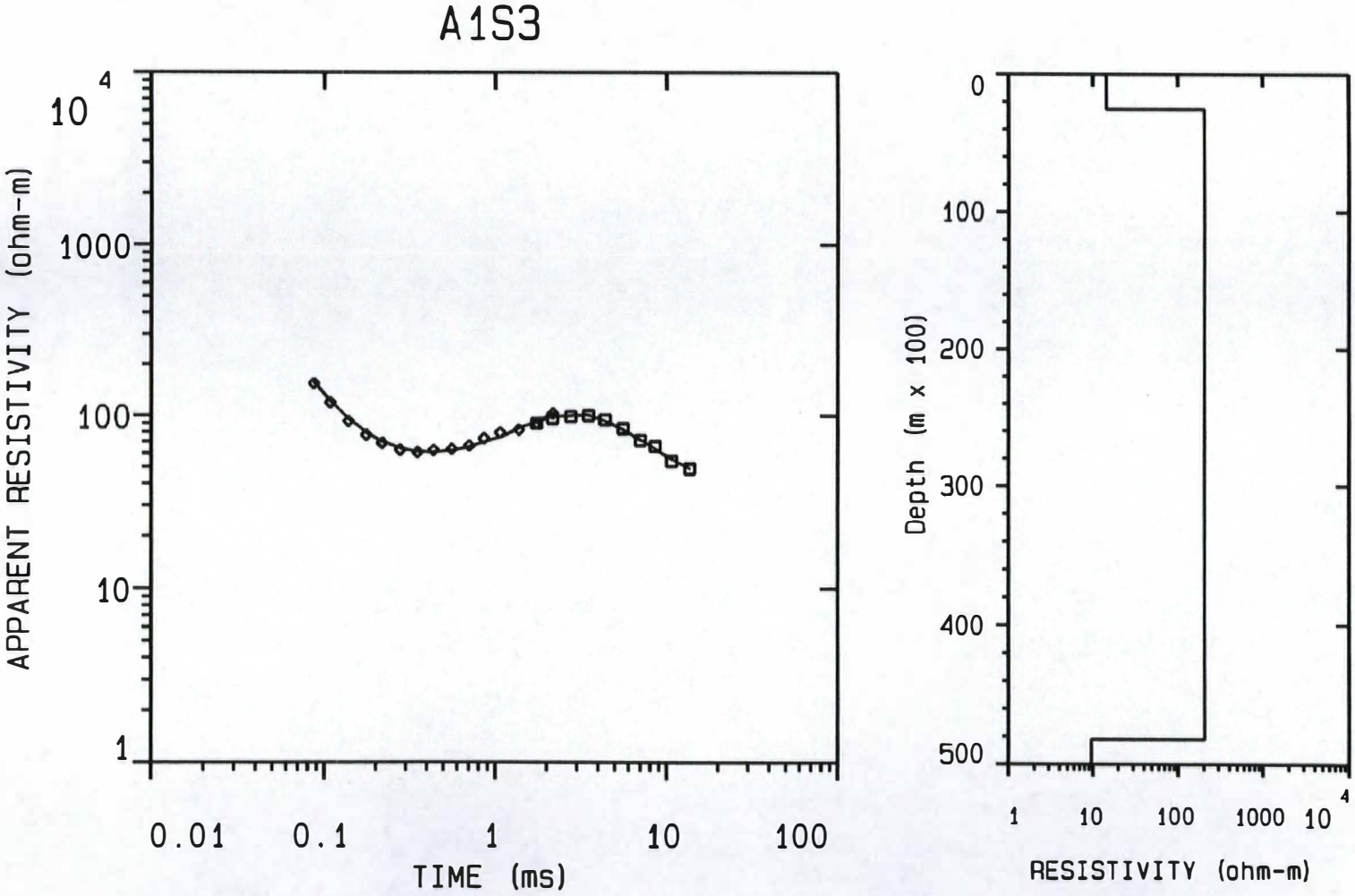
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	1.74	130.0	133.7	-2.81
2	2.17	82.49	83.77	-1.55
3	2.77	56.04	58.96	-5.21
4	3.50	40.44	40.24	0.492
5	4.37	29.34	30.14	-2.73
6	5.56	21.94	20.88	4.81
7	6.98	15.77	14.97	5.07
8	8.56	11.37	10.88	4.32
9	10.64	7.85	7.69	2.11
10	13.70	5.00	5.02	-0.377
11	17.40	3.34	3.32	0.857
12	21.70	2.07	2.20	-6.06

CURRENT: 16.80 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 1 RAMP TIME: 182.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.0867	178102.2	176784.4	0.739
14	0.108	144449.2	143189.2	0.872
15	0.138	106461.5	104372.7	1.96
16	0.175	71983.1	70571.2	1.96
17	0.218	45051.0	45602.5	-1.22
18	0.278	26055.5	26040.7	0.0570
19	0.351	14158.6	14229.9	-0.504
20	0.438	7317.3	7544.1	-3.09
21	0.558	3654.3	3646.1	0.225
22	0.702	1801.4	1740.7	3.37
23	0.858	890.7	895.5	-0.537
24	1.06	445.5	465.8	-4.55
25	1.37	227.4	213.1	6.28
26	1.74	120.9	123.8	-2.38

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.97				
P 2	0.01	0.05			
P 3	0.00	-0.04	0.87		
T 1	-0.03	-0.03	0.00	0.97	
T 2	0.00	0.02	0.02	0.00	0.99


A1S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.01
0.1
1
10
100
TIME (ms)
Depth (m x 100)
0
100
200
300
400
500
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A1S3

CLIENT: Lanai Water Company
DATE: 8-14-01
LOCATION: Area 1
SOUNDING: 1
COUNTY: Maui
ELEVATION: 405.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 3.0000 N:
1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.894 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			405.0	
1	14.40	25.64	379.3	1.78
2	203.5	456.2	-76.86	2.24
3	9.69			

ALL PARAMETERS ARE FREE

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 185.00 muSEC

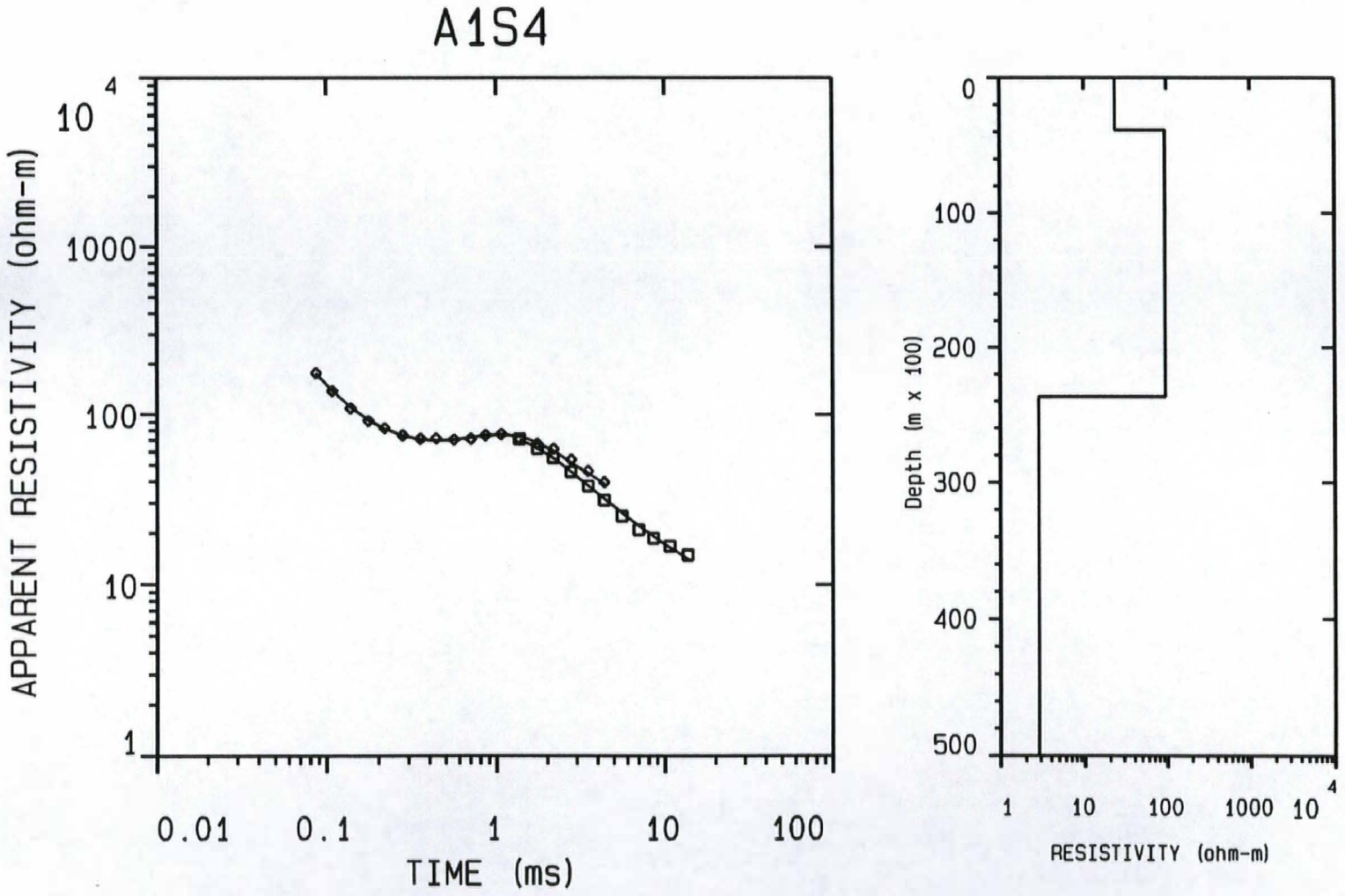
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.74	234.6	234.4	0.0949
2	2.17	122.1	115.5	5.44
3	2.77	63.32	62.58	1.16
4	3.50	34.85	34.27	1.67
5	4.37	21.85	22.34	-2.23
6	5.56	14.27	14.50	-1.57
7	6.98	10.24	10.10	1.37
8	8.56	6.93	7.26	-4.81
9	10.64	5.40	5.16	4.37
10	13.70	3.35	3.36	-0.154

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 5 RAMP TIME: 185.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0867	188243.0	181055.1	3.81
12	0.108	160076.2	154367.5	3.56
13	0.138	126151.2	120236.3	4.68
14	0.175	92355.7	87362.3	5.40
15	0.218	62523.8	60709.3	2.90
16	0.278	39064.1	37772.6	3.30
17	0.351	22787.8	22534.5	1.11
18	0.438	12610.3	13060.3	-3.56
19	0.558	6743.7	6927.5	-2.72
20	0.702	3547.4	3633.7	-2.43
21	0.858	1857.4	1994.5	-7.37
22	1.06	961.6	1050.6	-9.26
23	1.37	483.6	466.2	3.61
24	1.74	233.6	227.9	2.44
25	2.17	109.6	109.3	0.315

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.98				
P 2	0.01	0.83			
P 3	0.01	-0.12	0.52		
T 1	-0.02	-0.03	-0.01	0.97	
T 2	0.00	0.02	0.05	0.00	0.99


A1S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.01
0.1
1
10
100
TIME (ms)
0
100
200
300
400
500
Depth (m x 100)
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A1S4

CLIENT: Lanai Water Company
DATE: 8-15-01
LOCATION: Area 1
SOUNDING: 2
COUNTY: Maui
ELEVATION: 417.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 4.0000 N:
1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.734 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			417.0	
1	23.73	38.58	378.4	1.62
2	95.45	198.0	180.3	2.07
3	2.87			

ALL PARAMETERS ARE FREE

CURRENT: 17.10 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 190.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	1.37	604.0	613.5	-1.58
2	1.74	403.4	398.5	1.22
3	2.17	280.6	281.3	-0.249
4	2.77	202.4	203.0	-0.323
5	3.50	151.2	149.0	1.46
6	4.37	115.0	112.2	2.42
7	5.56	87.48	81.52	6.81
8	6.98	65.13	59.76	8.24
9	8.56	46.61	44.67	4.15
10	10.64	31.49	32.37	-2.78
11	13.70	20.08	21.83	-8.68

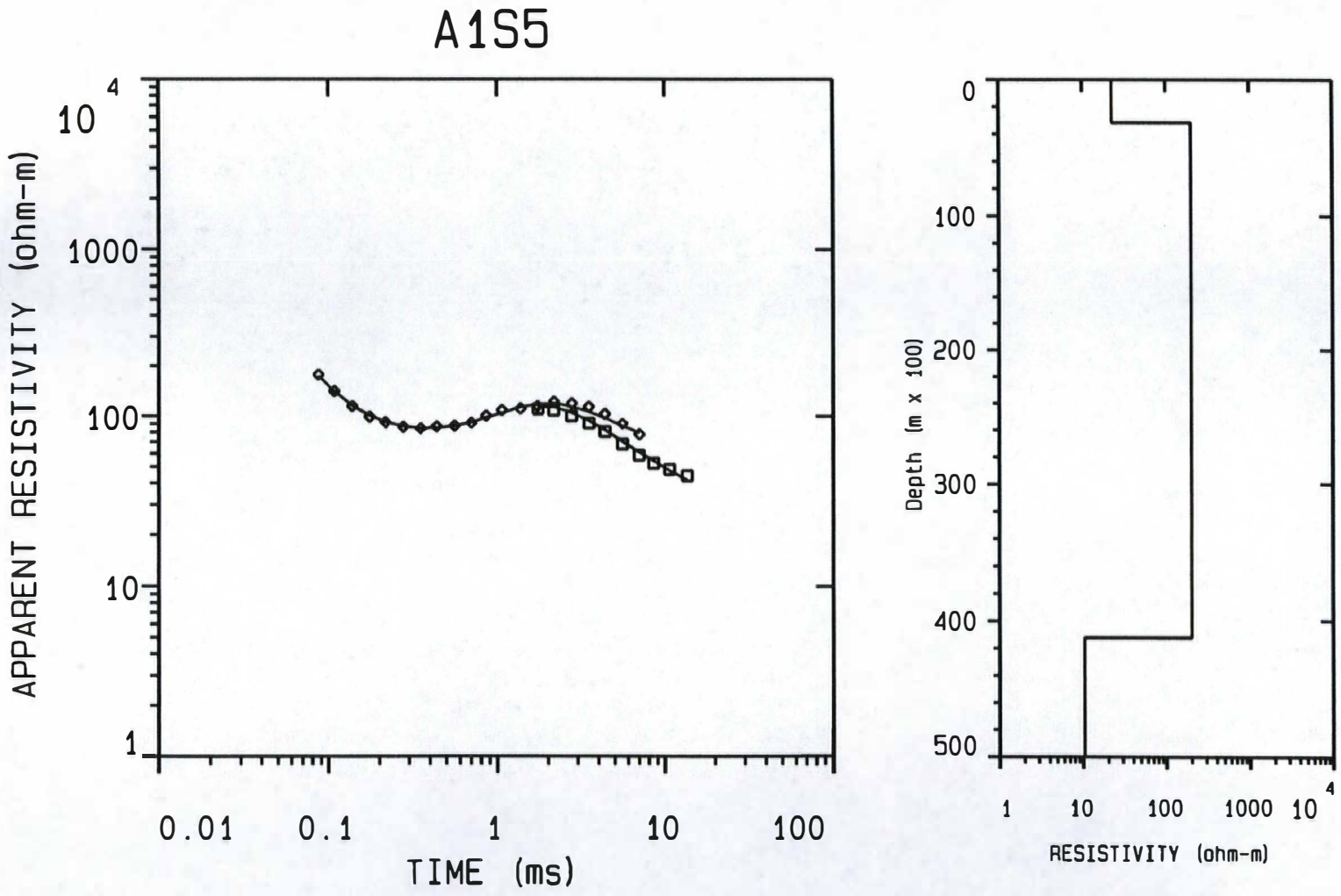
CURRENT: 17.10 AMPS EM-37 COIL AREA: 100.00 sq m.

FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 190.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	0.0867	155721.8	155238.7	0.310
13	0.108	129642.2	128689.8	0.734
14	0.138	99783.8	97840.0	1.94
15	0.175	71547.3	70148.5	1.95
16	0.218	48063.7	48601.0	-1.11
17	0.278	30242.2	30434.8	-0.636
18	0.351	18043.3	18318.7	-1.52
19	0.438	10328.6	10775.4	-4.32
20	0.558	5767.2	5792.1	-0.431
21	0.702	3203.4	3107.3	3.00
22	0.858	1798.5	1806.3	-0.432
23	1.06	1028.9	1030.3	-0.142
24	1.37	603.0	569.9	5.48
25	1.74	366.1	357.2	2.45
26	2.17	233.4	242.4	-3.88
27	2.77	157.8	167.3	-5.99
28	3.50	111.3	116.5	-4.65
29	4.37	80.46	83.24	-3.45

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.94				
P 2	-0.03	0.60			
P 3	0.01	-0.08	0.87		
T 1	-0.10	-0.24	-0.01	0.72	
T 2	0.02	0.07	0.01	0.06	0.98


A1S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.01
0.1
1
10
100
TIME (ms)
0
100
200
300
400
500
Depth (m x 100)
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A1S5

CLIENT: Lanai Water Company
DATE: 8-15-01
LOCATION: Area 1
SOUNDING: 2
COUNTY: Maui
ELEVATION: 460.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 305.000 m by 305.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 5.0000 N:
1.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.001 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			460.0	
1	22.65	31.69	428.3	1.39
2	202.1	380.5	47.74	1.88
3	10.35			

ALL PARAMETERS ARE FREE

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 186.00 muSEC

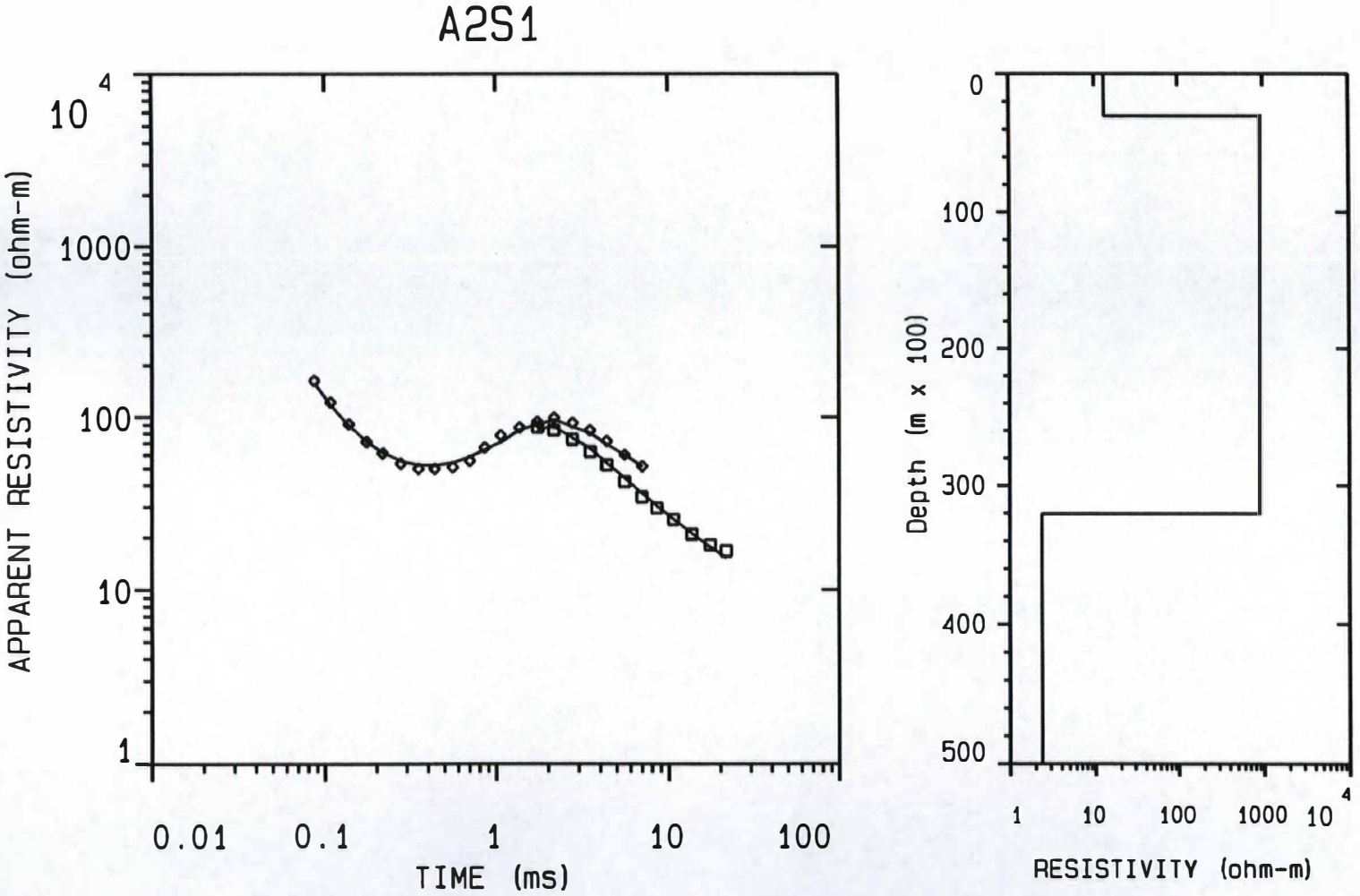
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.74	172.1	165.9	3.58
2	2.17	101.8	95.50	6.25
3	2.77	62.17	58.63	5.68
4	3.50	40.26	38.34	4.77
5	4.37	27.58	26.54	3.75
6	5.56	19.49	18.38	5.69
7	6.98	13.85	12.86	7.15
8	8.56	9.76	9.33	4.45
9	10.64	6.41	6.53	-1.95
10	13.70	3.88	4.26	-9.89

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 186.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
11	0.0867	152986.4	156804.1	-2.49
12	0.108	124147.8	124788.7	-0.516
13	0.138	92223.7	90023.8	2.38
14	0.175	63289.1	61183.3	3.32
15	0.218	40669.2	40449.7	0.539
16	0.278	24478.0	24122.7	1.45
17	0.351	14034.2	14008.2	0.185
18	0.438	7756.2	7990.4	-3.01
19	0.558	4173.2	4171.9	0.0298
20	0.702	2209.5	2191.0	0.836
21	0.858	1155.5	1202.0	-4.02
22	1.06	599.9	639.6	-6.62
23	1.37	311.1	299.7	3.63
24	1.74	161.9	157.6	2.68
25	2.17	85.54	87.66	-2.48
26	2.77	47.94	51.43	-7.27
27	3.50	28.65	31.83	-11.10
28	4.37	19.12	20.78	-8.69
29	5.56	12.80	13.46	-5.18
30	7.03	8.86	8.60	2.94

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.95				
P 2	0.00	0.80			
P 3	0.01	-0.09	0.80		
T 1	-0.06	-0.07	-0.01	0.90	
T 2	0.00	0.03	0.03	0.01	0.99
	P 1	P 2	P 3	T 1	T 2


A2S1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.01
0.1
1
10
100
TIME (ms)
Depth (m x 100)
0
100
200
300
400
500
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A2S1

CLIENT: Lanai Water Company
LOCATION: Area 2
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 305.000 m by 305.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 6.0000 N: 1.0000

DATE: 8-15-01
SOUNDING: 2
ELEVATION: 300.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 6.344 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			300.0	
1	13.05	30.29	269.7	2.31
2	924.5	290.0	-20.37	0.313
3	2.36			

ALL PARAMETERS ARE FREE

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 3.00 Hz GAIN: 7 RAMP TIME: 185.00 muSEC

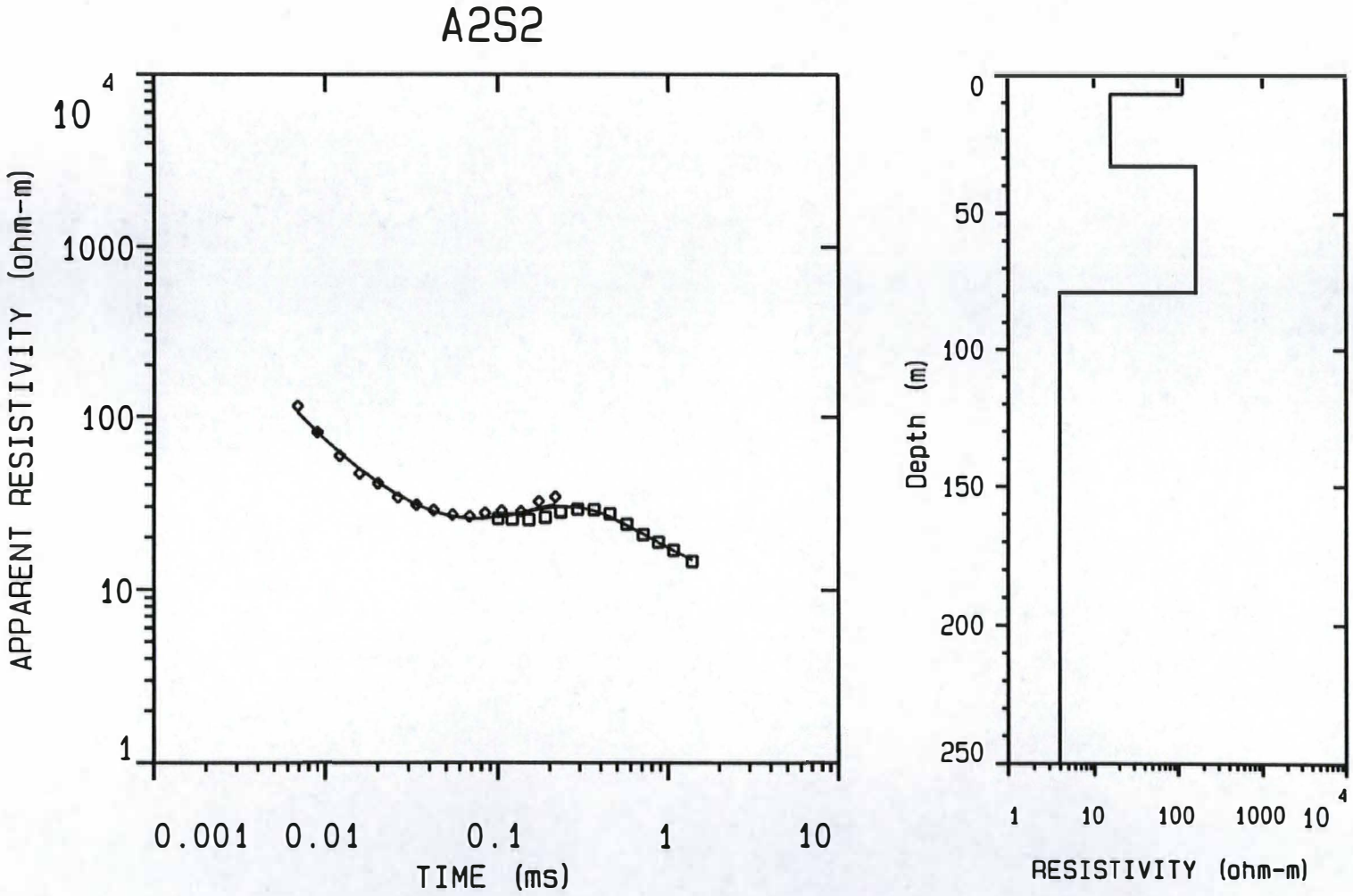
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	1.74	243.4	253.5	-4.12
2	2.17	148.6	140.5	5.47
3	2.77	97.87	95.00	2.93
4	3.50	69.79	65.16	6.63
5	4.37	52.23	50.36	3.57
6	5.56	40.20	37.12	7.68
7	6.98	30.79	28.49	7.46
8	8.56	23.10	22.13	4.20
9	10.64	16.92	16.74	1.09
10	13.70	12.03	11.86	1.41
11	17.40	8.21	8.51	-3.68
12	21.70	5.31	6.06	-14.00

CURRENT: 17.00 AMPS EM-37 COIL AREA: 100.00 sq m.
FREQUENCY: 30.00 Hz GAIN: 2 RAMP TIME: 185.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.0867	172336.2	182556.0	-5.93
14	0.108	154030.1	162118.5	-5.25
15	0.138	129870.0	132977.8	-2.39
16	0.175	102158.9	101582.1	0.564
17	0.218	74534.3	73526.1	1.35
18	0.278	49975.8	47329.0	5.29
19	0.351	30984.7	28637.8	7.57
20	0.438	17745.8	16574.1	6.60
21	0.558	9402.8	8596.5	8.57
22	0.702	4647.1	4302.7	7.41
23	0.858	2165.5	2252.9	-4.03
24	1.06	980.4	1122.5	-14.49
25	1.37	449.0	469.6	-4.57
26	1.74	218.9	232.5	-6.20
27	2.17	116.8	120.5	-3.14
28	2.77	70.10	76.28	-8.81
29	3.50	45.37	47.90	-5.57
30	4.37	32.33	34.74	-7.43
31	5.56	23.31	23.44	-0.553
32	7.03	16.33	16.41	-0.474

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.98				
P 2	0.02	0.02			
P 3	0.00	-0.03	0.78		
T 1	-0.02	-0.01	0.01	0.97	
T 2	0.00	0.01	0.00	0.00	1.00


A2S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
50
100
150
200
250
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A2S2

CLIENT: Lanai Water Company DATE: 8-16-01
LOCATION: Area 2 SOUNDING: 2
COUNTY: Maui ELEVATION: 128.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 61.000 m by 61.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 2.0000 N: 2.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 8.542 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			128.0	
1	114.6	6.97	121.0	0.0608
2	15.42	25.89	95.13	1.67
3	160.5	45.83	49.30	0.285
4	3.97			

ALL PARAMETERS ARE FREE

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 3.60 muSEC

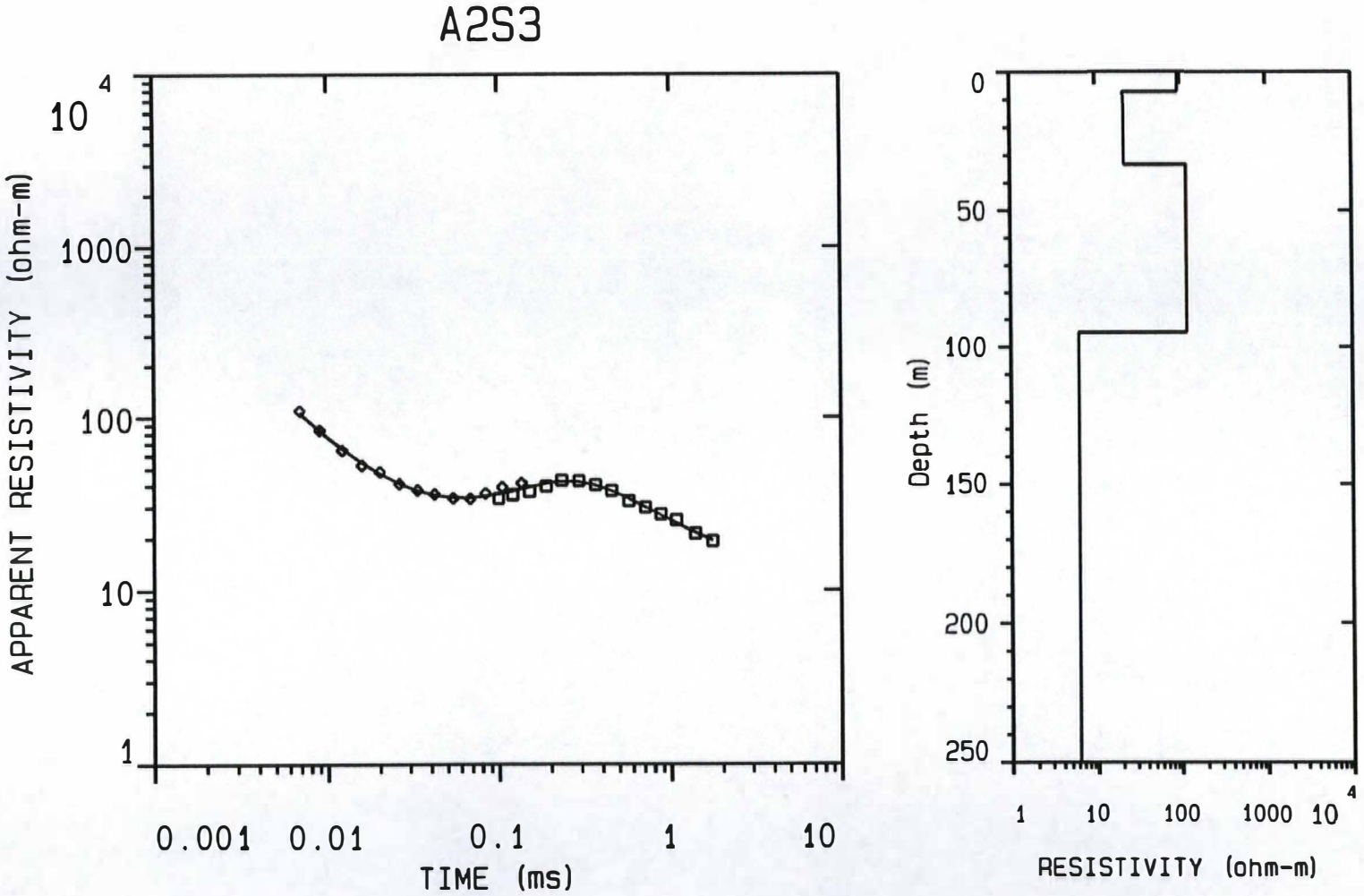
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	13651.3	13288.0	2.66
2	0.121	8578.7	7879.3	8.15
3	0.151	4979.9	4235.8	14.94
4	0.188	2749.5	2296.8	16.46
5	0.231	1472.0	1326.1	9.90
6	0.291	788.1	751.5	4.64
7	0.365	450.7	460.5	-2.19
8	0.452	286.9	302.6	-5.48
9	0.570	196.4	200.8	-2.25
10	0.712	139.0	136.7	1.68
11	0.871	97.51	97.52	-0.0112
12	1.08	66.87	67.40	-0.786
13	1.39	44.24	43.42	1.84

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 1 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.00685	1.165E+06	1.332E+06	-14.33
15	0.00895	1.016E+06	1.017E+06	-0.133
16	0.0120	771215.8	722737.6	6.28
17	0.0157	566645.1	517609.8	8.65
18	0.0200	377967.1	369260.8	2.30
19	0.0261	256437.0	245099.5	4.42
20	0.0334	161028.3	160701.0	0.203
21	0.0421	100270.8	103383.9	-3.10
22	0.0541	58945.3	60728.3	-3.02
23	0.0682	33917.7	35369.3	-4.27
24	0.0838	18999.9	21098.6	-11.04
25	0.104	10404.5	11674.2	-12.20
26	0.135	5530.4	5648.8	-2.14
27	0.172	2478.1	2838.1	-14.52
28	0.214	1302.1	1521.9	-16.88

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.12						
P 2	-0.01	0.97					
P 3	0.00	0.00	0.01				
P 4	0.00	0.02	-0.02	0.73			
T 1	0.16	0.04	0.00	-0.03	0.91		
T 2	-0.04	-0.05	-0.06	0.07	0.06	0.90	
T 3	0.00	0.01	0.06	0.04	-0.01	0.02	0.98
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A2S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
50
100
150
200
250
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A2S3

CLIENT: Lanai Water Company
DATE: 8-16-01
LOCATION: Area 2
SOUNDING: 2
COUNTY: Maui
ELEVATION: 110.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 61.000 m by 61.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 3.0000 N: 2.0000
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.162 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			110.0	
1	94.87	7.06	102.9	0.0745
2	21.69	26.14	76.78	1.20
3	117.1	61.46	15.32	0.524
4	6.13			

ALL PARAMETERS ARE FREE

CURRENT: 3.00 AMPS
EM-47
COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz
GAIN: 7
RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	9000.9	8272.2	8.09
2	0.121	5187.3	4829.1	6.90
3	0.151	2788.2	2559.7	8.19
4	0.188	1463.6	1378.9	5.78
5	0.231	775.5	791.9	-2.11
6	0.291	438.7	449.0	-2.36
7	0.365	270.3	273.0	-0.987
8	0.452	178.4	179.4	-0.569
9	0.570	122.3	117.5	3.93
10	0.712	80.28	79.77	0.630
11	0.871	55.31	56.31	-1.80
12	1.08	36.48	38.67	-5.98
13	1.39	25.36	24.66	2.72

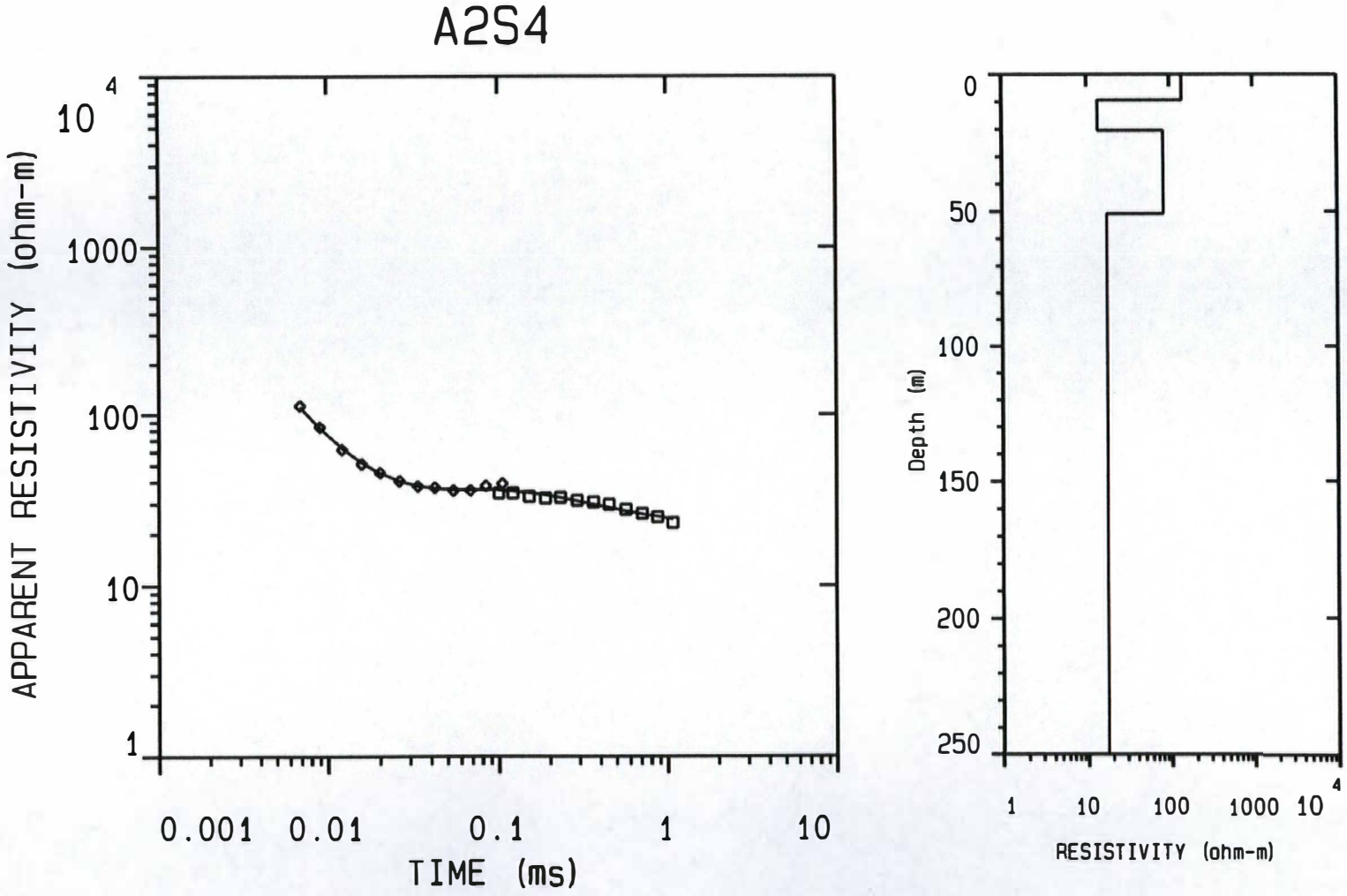
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	16.45	16.21	1.48

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 1 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	0.00685	1.258E+06	1.315E+06	-4.53
16	0.00895	955512.9	963642.5	-0.850
17	0.0120	679525.8	652646.6	3.95
18	0.0157	473426.8	447213.6	5.53
19	0.0200	294121.6	304392.0	-3.49
20	0.0261	192457.6	191340.0	0.580
21	0.0334	118158.0	118882.8	-0.613
22	0.0421	71631.0	73126.0	-2.08
23	0.0541	41570.0	40991.6	1.39
24	0.0682	23460.4	23063.7	1.69
25	0.0838	12635.2	13383.4	-5.92
26	0.104	6421.1	7246.0	-12.84
27	0.135	3094.9	3434.6	-10.97

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.13						
P 2	0.00	0.96					
P 3	0.01	-0.02	0.08				
P 4	0.01	0.02	-0.05	0.83			
T 1	0.26	0.06	0.02	-0.03	0.81		
T 2	-0.05	-0.06	-0.16	0.04	0.11	0.86	
T 3	-0.01	0.01	0.12	0.04	-0.01	0.03	0.97
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A2S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
0
50
100
150
200
250
Depth (m)
1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A2S4

CLIENT: Lanai Water Comany DATE: 8-16-01
LOCATION: Area 2 SOUNDING: 2
COUNTY: Maui ELEVATION: 100.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 61.000 m by 61.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 4.0000 N: 2.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.786 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			100.0	
1	139.0	9.33	90.66	0.0671
2	13.46	11.03	79.63	0.819
3	83.85	30.43	49.20	0.362
4	17.24			

ALL PARAMETERS ARE FREE

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 3.60 muSEC

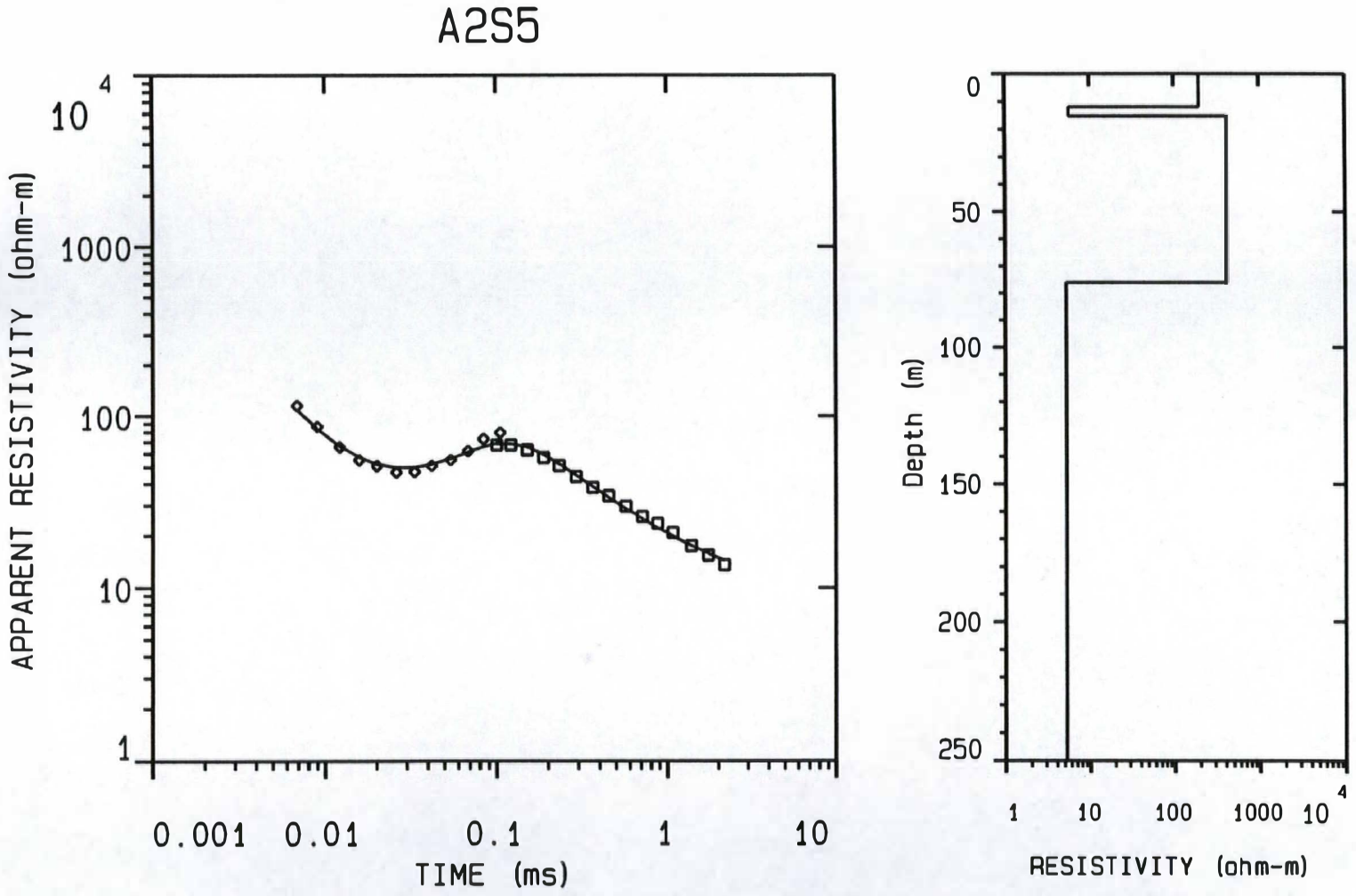
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	8653.6	8191.2	5.34
2	0.121	5424.6	5169.6	4.69
3	0.151	3317.7	3071.5	7.42
4	0.188	1982.2	1862.3	6.04
5	0.231	1175.3	1175.5	-0.0173
6	0.291	697.1	706.3	-1.32
7	0.365	410.1	429.7	-4.77
8	0.452	251.0	268.9	-7.09
9	0.570	156.9	160.7	-2.40
10	0.712	97.05	98.33	-1.31
11	0.871	62.85	62.23	0.987
12	1.08	41.06	38.47	6.32

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 2 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.00685	1.207E+06	1.241E+06	-2.77
14	0.00895	961370.8	975232.8	-1.44
15	0.0120	720531.6	695793.5	3.43
16	0.0157	495585.2	482294.1	2.68
17	0.0200	322749.3	323669.8	-0.285
18	0.0261	194979.1	195915.6	-0.480
19	0.0334	117088.3	116672.2	0.355
20	0.0421	67896.5	68960.1	-1.56
21	0.0541	38433.4	37601.0	2.16
22	0.0682	21383.6	21130.3	1.18
23	0.0838	11721.0	12609.3	-7.57
24	0.104	6425.9	7291.3	-13.46

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.12						
P 2	0.00	0.77					
P 3	0.02	-0.01	0.15				
P 4	0.00	0.03	-0.02	0.96			
T 1	0.12	0.14	-0.01	-0.01	0.89		
T 2	-0.05	-0.30	-0.17	0.04	0.18	0.57	
T 3	-0.01	-0.01	0.23	0.05	0.01	0.01	0.87
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A2S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
50
100
150
200
250
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A2S5

CLIENT: Lanai Water Comany DATE: 8-16-01
LOCATION: Area 2 SOUNDING: 2
COUNTY: Maui ELEVATION: 78.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 61.000 m by 61.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 5.0000 N: 2.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 7.226 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			78.00	
1	199.6	11.90	66.09	0.0596
2	5.66	3.30	62.78	0.583
3	422.1	60.81	1.96	0.144
4	5.24			

ALL PARAMETERS ARE FREE

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	3198.8	3139.7	1.84
2	0.121	1976.9	1932.3	2.25
3	0.151	1256.9	1187.2	5.55
4	0.188	848.6	796.7	6.12
5	0.231	592.4	570.6	3.68
6	0.291	414.7	404.1	2.55
7	0.365	292.8	289.0	1.28
8	0.452	203.6	210.2	-3.23
9	0.570	140.8	148.0	-5.14
10	0.712	98.97	103.7	-4.78
11	0.871	68.96	75.20	-9.04
12	1.08	48.51	51.97	-7.13
13	1.39	33.52	33.54	-0.0614

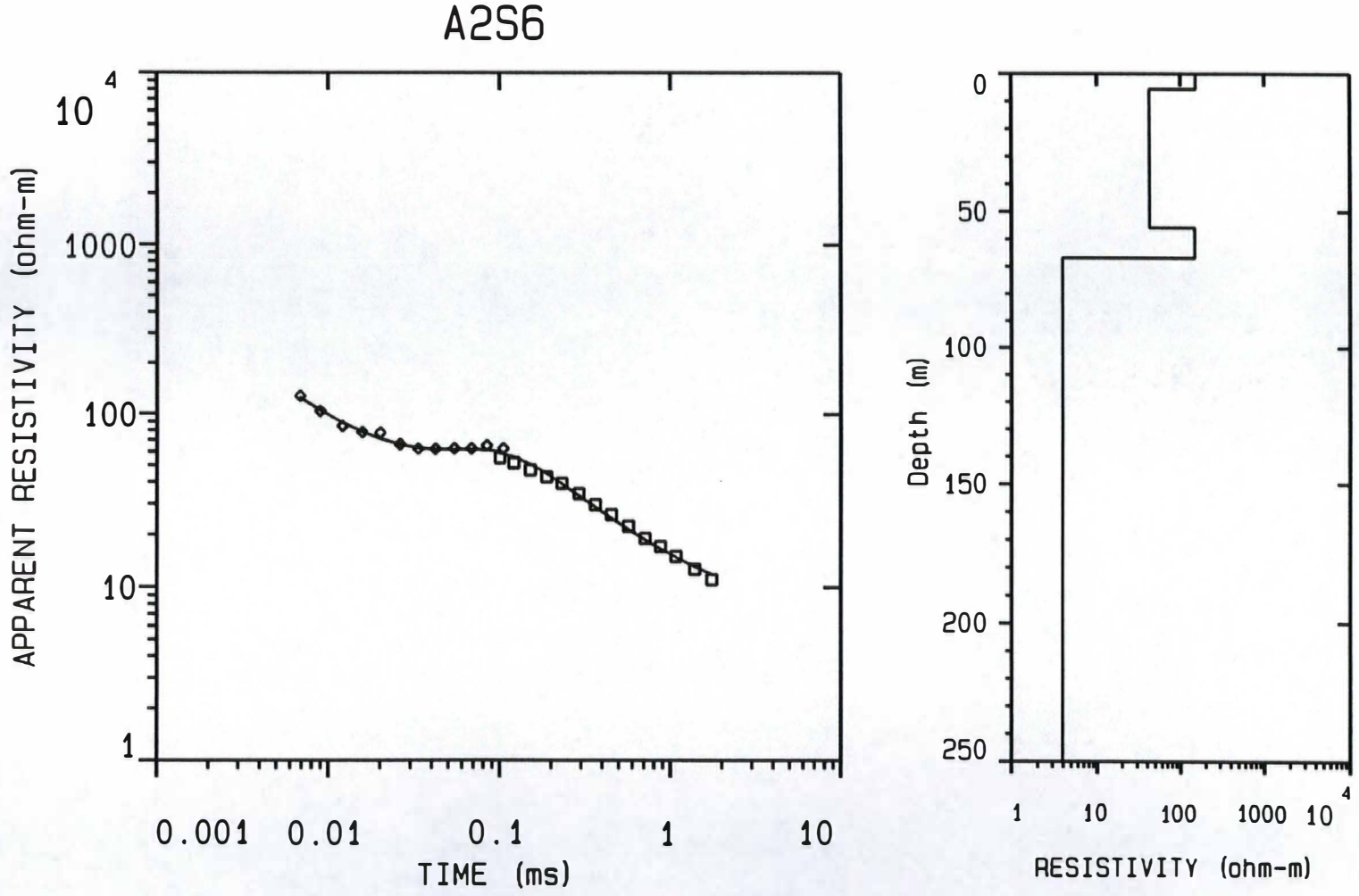
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	22.85	22.06	3.47
15	2.18	16.00	14.52	9.22

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 1 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
16	0.00685	1.165E+06	1.262E+06	-8.38
17	0.00895	919651.8	957867.5	-4.15
18	0.0120	656807.0	643660.8	2.00
19	0.0157	441793.6	417641.4	5.46
20	0.0200	270654.0	260382.5	3.79
21	0.0261	156927.7	143354.1	8.64
22	0.0334	84003.4	77161.3	8.14
23	0.0421	42055.2	40835.3	2.90
24	0.0541	20015.9	19481.7	2.66
25	0.0682	9378.3	9580.0	-2.15
26	0.0838	4395.0	5134.6	-16.82
27	0.104	2231.4	2708.9	-21.40

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.11						
P 2	0.02	0.61					
P 3	0.01	-0.01	0.03				
P 4	0.00	0.05	-0.02	0.92			
T 1	0.07	0.09	-0.02	-0.01	0.95		
T 2	-0.05	-0.39	-0.08	0.05	0.09	0.59	
T 3	-0.01	-0.01	0.03	0.02	0.01	-0.01	0.99
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A2S6
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
50
100
150
200
250
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A2S6

CLIENT: Lanai Water Comany DATE: 8-16-01
LOCATION: Area 2 SOUNDING: 2
COUNTY: Maui ELEVATION: 70.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 61.000 m by 61.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 6.0000 N: 2.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 6.353 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			70.00	
1	153.2	5.57	64.42	0.0363
2	42.47	50.18	14.24	1.18
3	148.8	11.08	3.15	0.0744
4	3.93			

ALL PARAMETERS ARE FREE

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	4308.9	3901.2	9.46
2	0.121	2948.5	2625.7	10.94
3	0.151	1954.2	1748.7	10.51
4	0.188	1299.8	1216.6	6.40
5	0.231	883.8	887.3	-0.397
6	0.291	609.4	629.9	-3.35
7	0.365	430.3	451.3	-4.87
8	0.452	305.3	327.8	-7.37
9	0.570	216.5	229.6	-6.06
10	0.712	158.2	161.7	-2.19
11	0.871	112.3	116.2	-3.51
12	1.08	79.11	80.96	-2.33
13	1.39	54.41	51.99	4.45

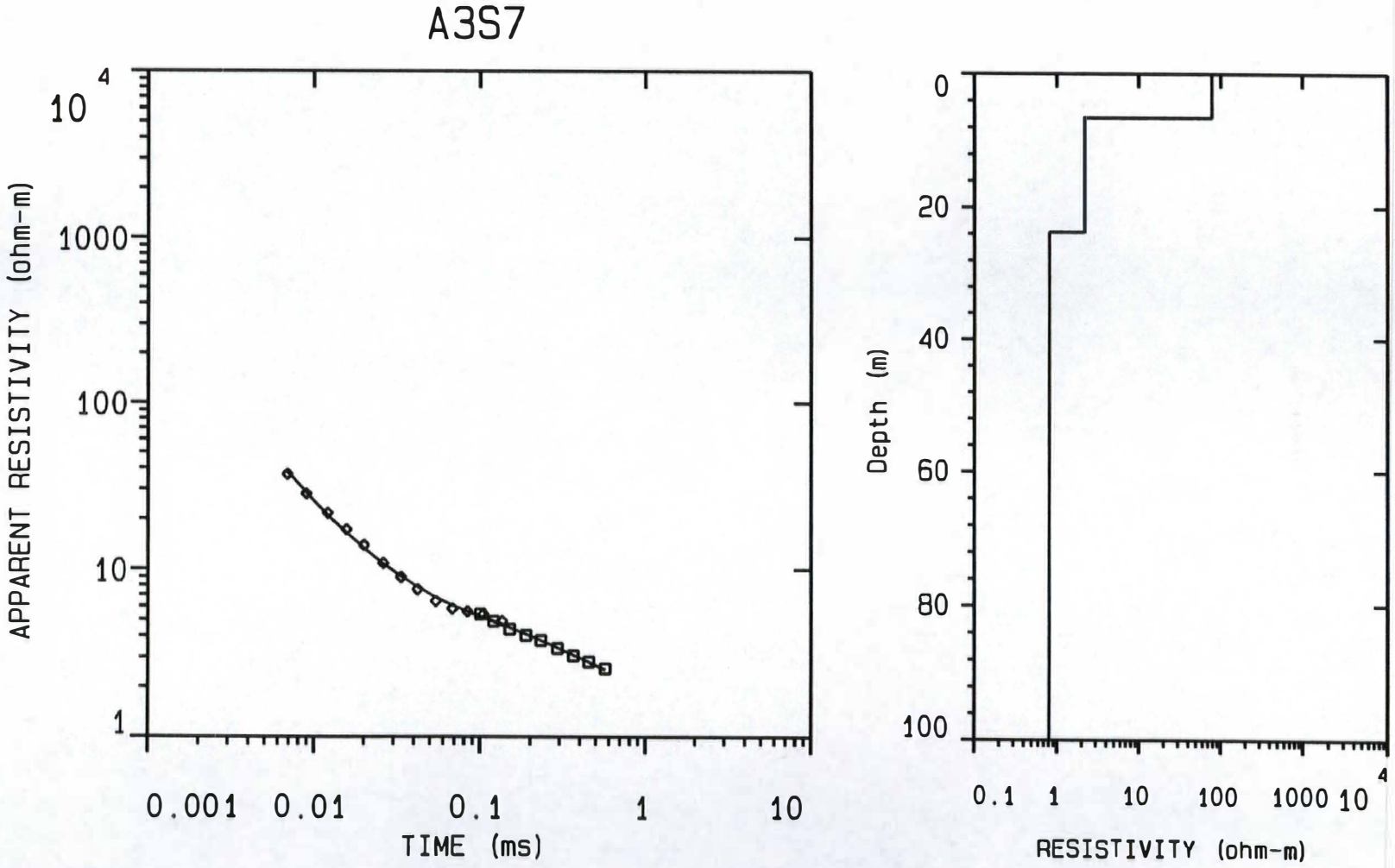
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	37.74	34.15	9.50

CURRENT: 3.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 1 RAMP TIME: 3.60 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	0.00685	1.011E+06	1.031E+06	-1.98
16	0.00895	701429.3	688801.5	1.80
17	0.0120	448670.3	418911.2	6.63
18	0.0157	264403.7	260828.9	1.35
19	0.0200	145527.5	163362.2	-12.25
20	0.0261	93829.5	94089.5	-0.277
21	0.0334	55350.2	54511.8	1.51
22	0.0421	31419.1	31547.9	-0.409
23	0.0541	16571.4	16937.0	-2.20
24	0.0682	9301.9	9442.3	-1.50
25	0.0838	5229.3	5702.7	-9.05
26	0.104	3192.3	3426.1	-7.32

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.11						
P 2	0.01	0.99					
P 3	-0.01	0.01	0.00				
P 4	0.01	0.00	-0.01	0.94			
T 1	0.28	0.04	-0.01	0.01	0.73		
T 2	-0.02	-0.01	0.00	0.03	0.04	0.93	
T 3	-0.04	0.03	0.02	-0.06	-0.07	0.21	0.24
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A3S7
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A3S7

CLIENT: Lanai Water Comany DATE: 8-16-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 17.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 30.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.174 PERCENT
SMOOTH MODEL FITTING ERROR: 3.118 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			17.00	
1	78.04	6.56	10.43	0.0841
2	2.20	17.20	-6.77	7.81
3	0.812			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

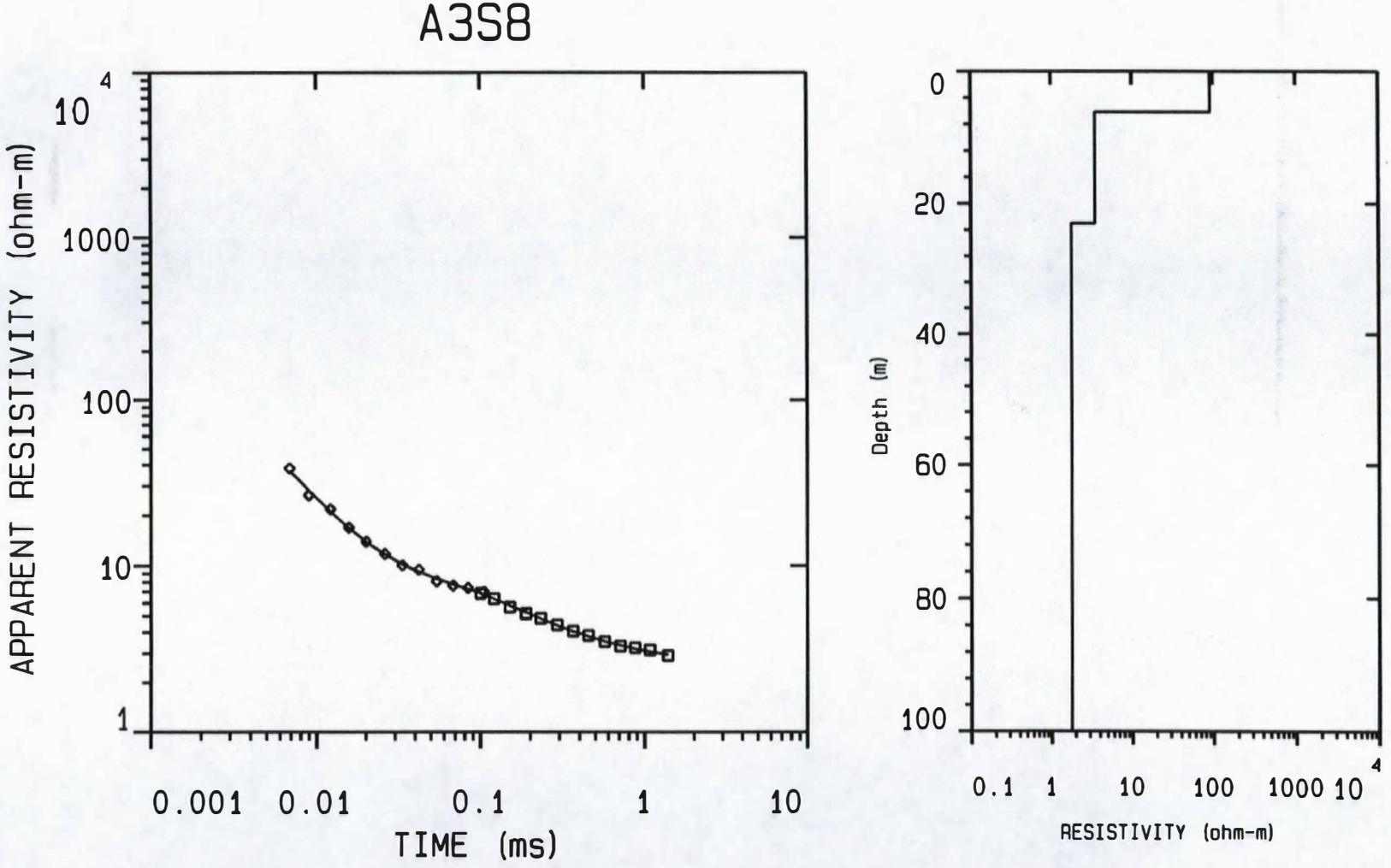
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	22805.5	24097.4	-5.66
2	0.121	16366.9	16597.1	-1.40
3	0.151	11057.7	10770.2	2.60
4	0.188	7295.5	7067.2	3.13
5	0.231	4809.4	4791.7	0.367
6	0.291	3169.8	3126.8	1.35
7	0.365	2102.9	2066.1	1.74
8	0.452	1385.0	1398.9	-1.00
9	0.570	896.2	913.1	-1.88

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
10	0.00685	1.048E+06	994239.2	5.11
11	0.00895	804275.2	782952.6	2.65
12	0.0120	563588.7	583083.8	-3.45
13	0.0157	410924.7	437388.2	-6.43
14	0.0200	307162.0	327388.0	-6.58
15	0.0261	229867.2	231398.8	-0.666
16	0.0334	165057.6	163170.0	1.14
17	0.0421	119273.6	114346.4	4.13
18	0.0541	81008.3	75129.1	7.25
19	0.0682	53180.3	49512.8	6.89
20	0.0838	33528.0	33502.3	0.0767
21	0.104	20495.8	21690.2	-5.82
22	0.135	12304.8	12916.0	-4.96

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.02				
P 2	-0.02	0.99			
P 3	-0.02	-0.04	0.59		
T 1	0.04	0.01	0.01	0.99	
T 2	0.00	0.01	0.11	0.00	0.95
	P 1	P 2	P 3	T 1	T 2


A3S8
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A3S8

CLIENT: Lanai Water Comany DATE: 8-16-01
LOCATION: Area3 SOUNDING: 2
COUNTY: Maui ELEVATION: 19.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 0.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.450 PERCENT
SMOOTH MODEL FITTING ERROR: 3.532 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			19.00	
1	91.60	6.13	12.86	0.0669
2	3.56	16.85	-3.98	4.72
3	1.80			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

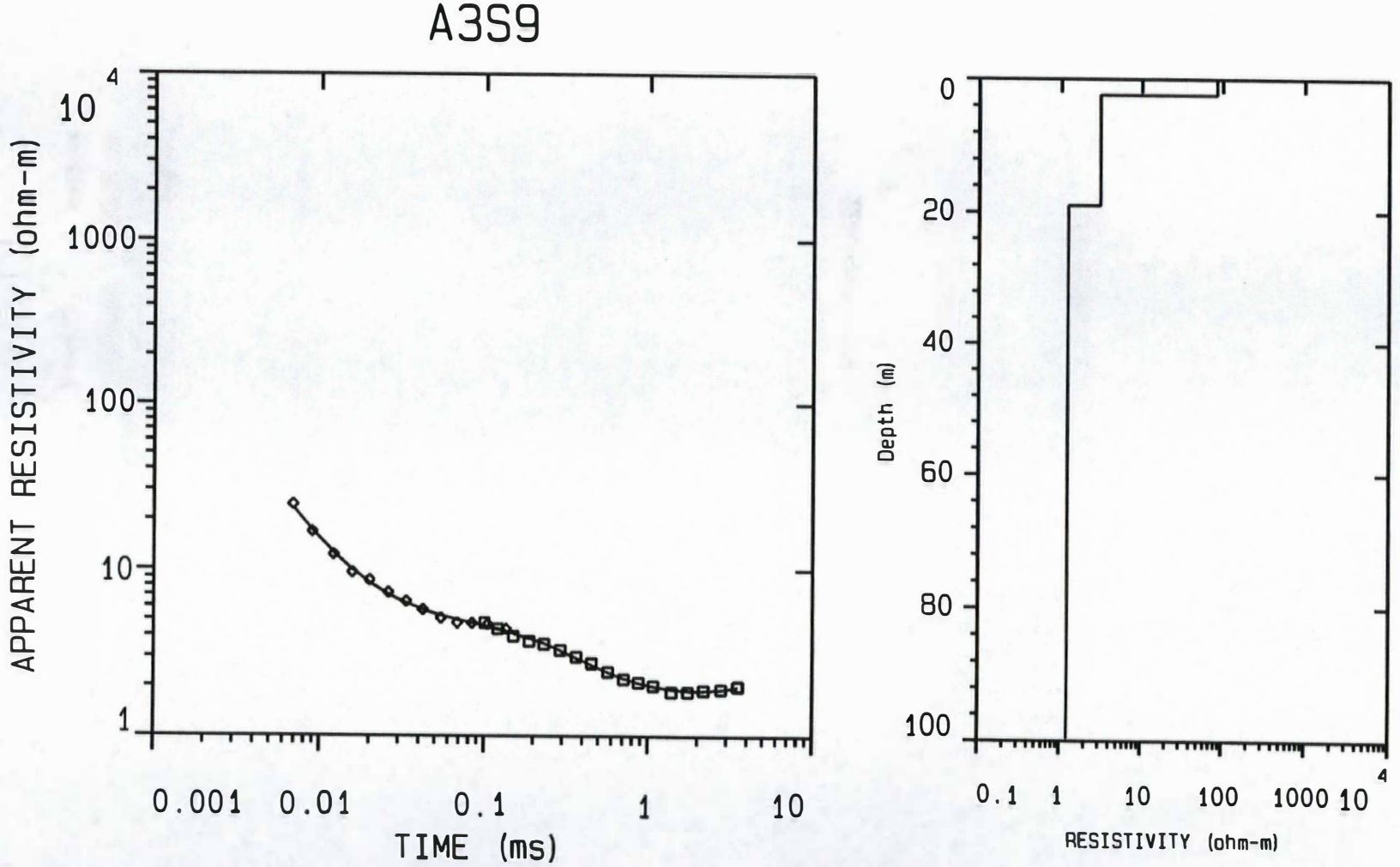
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	15986.9	16131.8	-0.906
2	0.121	11031.4	11137.7	-0.963
3	0.151	7595.9	7320.0	3.63
4	0.188	4989.1	4859.5	2.59
5	0.231	3283.0	3308.8	-0.786
6	0.291	2127.5	2133.4	-0.281
7	0.365	1367.5	1375.2	-0.561
8	0.452	875.7	895.1	-2.21
9	0.570	556.4	555.9	0.0777
10	0.712	351.5	346.7	1.36
11	0.871	218.3	224.0	-2.60
12	1.08	134.0	139.2	-3.86
13	1.39	80.47	78.66	2.25

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 285.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.00685	982765.7	1.031E+06	-4.86
15	0.00895	882518.0	798744.5	9.49
16	0.0120	552739.1	581450.6	-5.19
17	0.0157	420399.6	424102.0	-0.880
18	0.0200	305007.5	305629.0	-0.203
19	0.0261	202711.8	204304.5	-0.785
20	0.0334	138253.6	135338.5	2.10
21	0.0421	85317.7	89006.3	-4.32
22	0.0541	57520.3	54773.0	4.77
23	0.0682	35545.2	34417.1	3.17
24	0.0838	22192.1	22694.3	-2.26
25	0.104	13742.8	14568.5	-6.00

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.01				
P 2	-0.01	0.99			
P 3	0.00	-0.01	0.96		
T 1	0.05	0.01	0.00	0.99	
T 2	-0.01	0.01	0.05	-0.01	0.93
	P 1	P 2	P 3	T 1	T 2


A3S9
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
0
20
40
60
80
100
Depth (m)
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A3S9

CLIENT: Lanai Water Company
DATE: 8-17-01
LOCATION: Area 3
SOUNDING: 2
COUNTY: Maui
ELEVATION: 15.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 60.0000 N: 1000.0000
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 7.737 PERCENT
SMOOTH MODEL FITTING ERROR: 3.890 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			15.00	
1	85.02	2.43	12.56	0.0286
2	3.04	16.60	-4.03	5.45
3	1.23			

ALL PARAMETERS ARE FREE

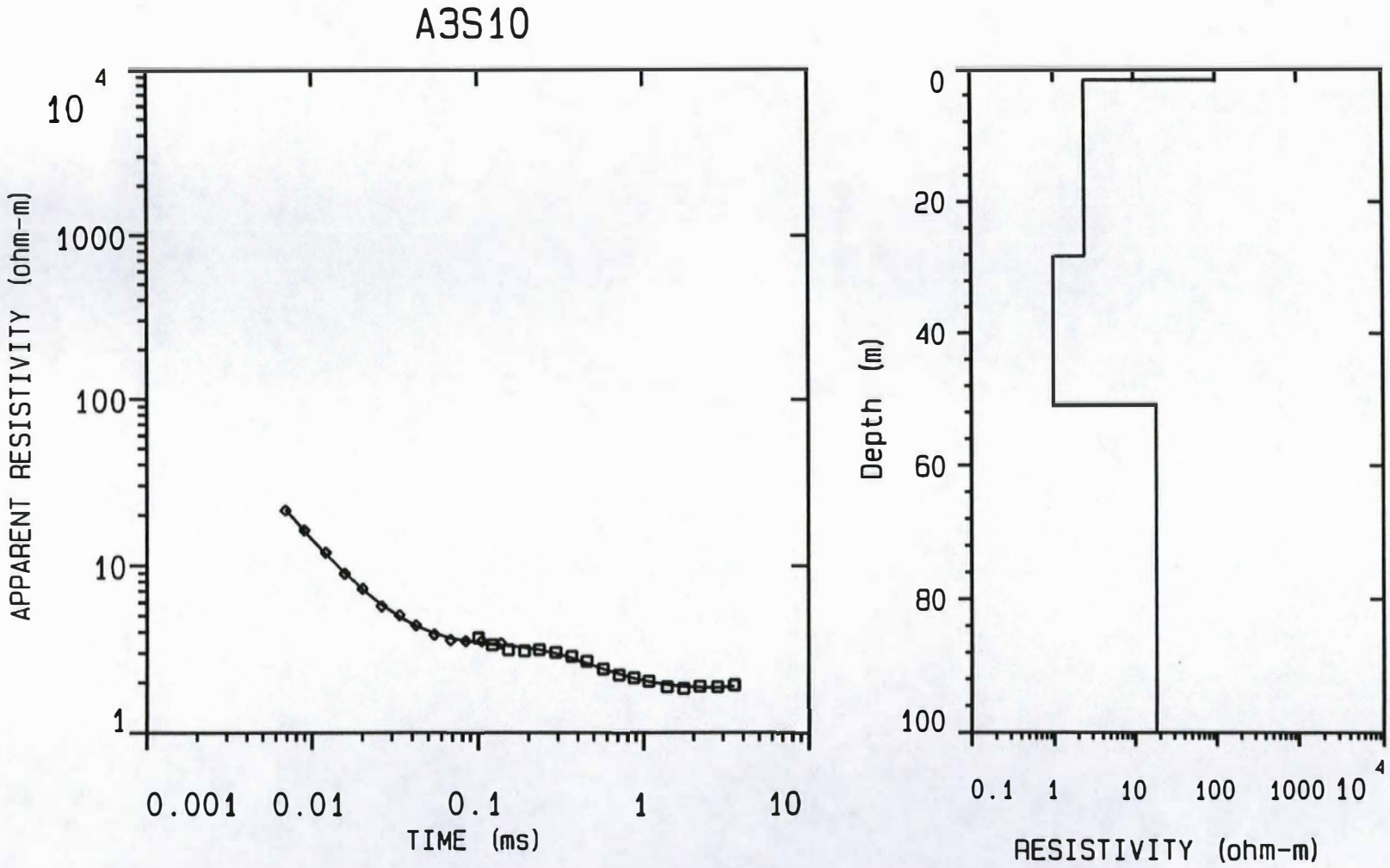
CURRENT: 2.00 AMPS EM-47
COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7
RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	27288.5	29438.4	-7.87
2	0.121	19360.0	19481.1	-0.625
3	0.151	12849.7	12174.4	5.25
4	0.188	8200.0	7744.3	5.55
5	0.231	5188.1	5157.1	0.596
6	0.291	3316.0	3335.2	-0.578
7	0.365	2171.1	2209.9	-1.78
8	0.452	1447.9	1501.0	-3.66
9	0.570	971.7	978.7	-0.720
10	0.712	644.6	636.1	1.32
11	0.871	417.8	422.0	-1.01
12	1.08	260.7	265.8	-1.96
13	1.39	157.1	149.8	4.64

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	88.84	86.48	2.65
15	2.18	49.31	49.88	-1.15
16	2.78	26.43	26.59	-0.591
17	3.52	13.71	13.99	-2.03

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 1 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
18	0.00685	1.936E+06	2.050E+06	-5.87
19	0.00895	1.735E+06	1.674E+06	3.52
20	0.0120	1.311E+06	1.261E+06	3.82
21	0.0157	984691.4	927744.8	5.78
22	0.0200	628627.9	663095.1	-5.48
23	0.0261	417068.1	434569.5	-4.19
24	0.0334	271396.8	281418.3	-3.69
25	0.0421	181485.4	181154.5	0.182
26	0.0541	115331.0	108861.0	5.60
27	0.0682	71105.7	66678.9	6.22
28	0.0838	42590.1	42662.9	-0.170


A3S10
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A3S10

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 13.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 90.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.167 PERCENT
SMOOTH MODEL FITTING ERROR: 3.787 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			13.00	
1	101.3	1.74	11.25	0.0172
2	2.40	26.53	-15.28	11.03
3	0.973	22.51	-37.79	23.13
4	18.09			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	40229.1	44797.6	-11.35
2	0.121	28892.0	28628.8	0.910
3	0.151	18457.4	16927.1	8.29
4	0.188	10835.6	10113.6	6.66
5	0.231	6330.4	6334.3	-0.0612
6	0.291	3760.7	3842.2	-2.16
7	0.365	2326.2	2412.9	-3.72
8	0.452	1504.4	1575.4	-4.72
9	0.570	988.8	995.0	-0.617
10	0.712	647.3	633.6	2.11
11	0.871	414.3	415.9	-0.375
12	1.08	257.6	260.7	-1.23

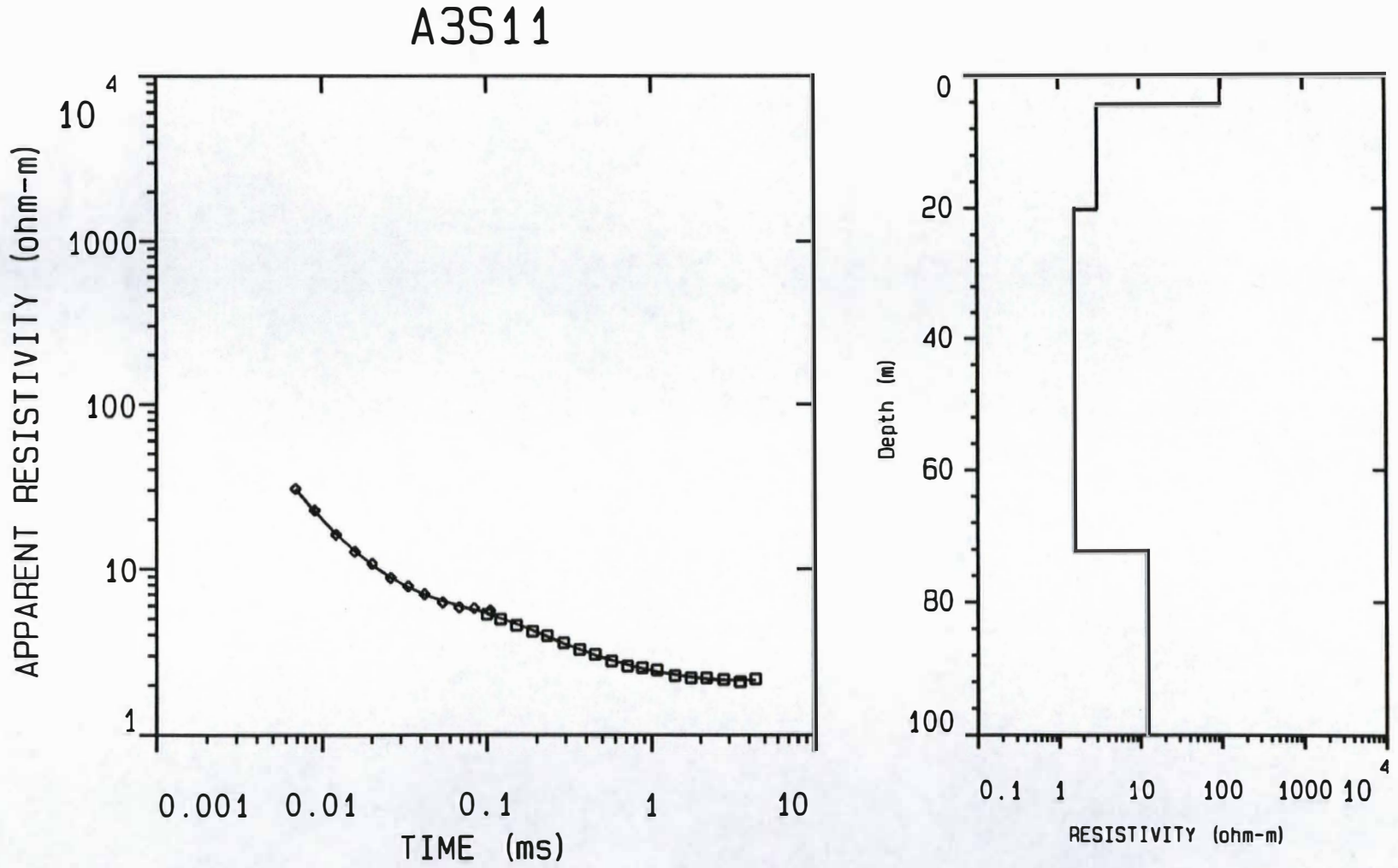
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	1.39	154.4	147.5	4.46
14	1.75	89.69	86.10	3.99
15	2.18	49.63	50.48	-1.71
16	2.78	27.27	27.63	-1.34
17	3.52	14.52	14.97	-3.09

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
18	0.00685	2.357E+06	2.318E+06	1.65
19	0.00895	1.817E+06	1.834E+06	-0.911
20	0.0120	1.360E+06	1.394E+06	-2.53
21	0.0157	1.093E+06	1.074E+06	1.72
22	0.0200	813445.6	818666.5	-0.641
23	0.0261	598432.0	580473.0	3.00
24	0.0334	389225.3	402468.2	-3.40
25	0.0421	269370.8	272431.4	-1.13
26	0.0541	173875.3	169751.0	2.37
27	0.0682	109967.2	105048.3	4.47
28	0.0838	66888.0	66710.5	0.265
29	0.104	38540.5	39873.5	-3.45
30	0.135	20984.8	21449.9	-2.21

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.03						
P 2	0.00	1.00					
P 3	0.00	0.00	0.83				
P 4	0.01	0.00	0.00	0.01			
T 1	0.03	0.01	0.01	0.00	0.95		
T 2	0.00	0.00	0.09	-0.01	-0.01	0.93	
T 3	-0.02	-0.01	-0.26	-0.04	0.01	0.15	0.56
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A3S11
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A3S11

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 12.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 120.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.887 PERCENT
SMOOTH MODEL FITTING ERROR: 2.439 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			12.00	
1	98.25	4.36	7.63	0.0444
2	3.01	15.83	-8.19	5.24
3	1.53	52.21	-60.41	34.07
4	11.97			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	23261.6	23085.0	0.759
2	0.121	15950.2	15712.4	1.49
3	0.151	10439.3	10174.1	2.53
4	0.188	6831.4	6702.3	1.88
5	0.231	4475.6	4548.8	-1.63
6	0.291	2919.7	2947.2	-0.942
7	0.365	1906.3	1909.1	-0.144
8	0.452	1239.7	1256.0	-1.31
9	0.570	798.9	785.7	1.66
10	0.712	507.9	494.8	2.56
11	0.871	315.9	321.3	-1.69
12	1.08	193.0	200.7	-4.00

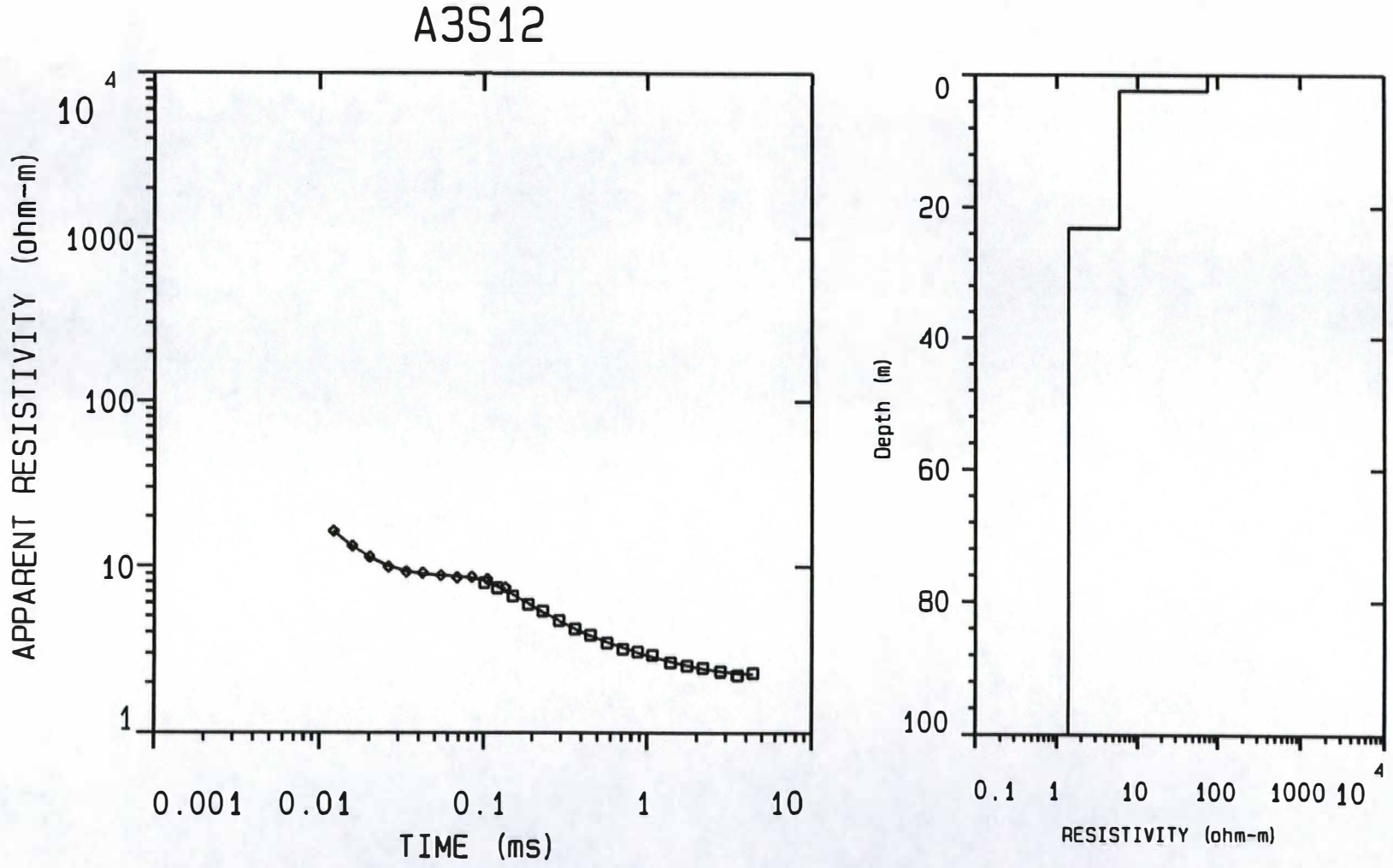
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	1.39	115.9	113.8	1.78
14	1.75	67.97	66.98	1.44
15	2.18	39.44	40.02	-1.47
16	2.78	22.23	22.30	-0.282
17	3.52	12.83	12.47	2.82
18	4.39	7.01	7.14	-1.89

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
19	0.00685	1.381E+06	1.384E+06	-0.172
20	0.00895	1.112E+06	1.120E+06	-0.685
21	0.0120	864944.4	847736.3	1.98
22	0.0157	645499.2	634227.5	1.74
23	0.0200	451116.0	463346.8	-2.71
24	0.0261	310982.8	311620.4	-0.205
25	0.0334	200832.2	205951.9	-2.54
26	0.0421	133684.4	134550.6	-0.647
27	0.0541	84630.1	81772.6	3.37
28	0.0682	52584.3	50642.0	3.69
29	0.0838	31923.5	32860.3	-2.93
30	0.104	19261.0	20712.0	-7.53

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.00						
P 2	-0.01	0.99					
P 3	0.00	0.00	0.99				
P 4	0.00	0.00	-0.01	0.01			
T 1	0.04	0.01	0.00	0.00	0.99		
T 2	-0.01	0.01	0.02	0.00	-0.01	0.94	
T 3	-0.01	-0.01	-0.03	-0.05	0.01	0.05	0.86
	P 1	P 2	P 3	P 4	T 1	T 2	T 3


A3S12
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A3S12

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 11.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 150.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.612 PERCENT
SMOOTH MODEL FITTING ERROR: 2.186 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			11.00	
1	74.68	2.39	8.60	0.0320
2	5.84	20.79	-12.19	3.55
3	1.39	173.2	-185.4	124.5
4	11.83			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	12735.1	12523.4	1.66
2	0.121	8830.4	8603.7	2.56
3	0.151	6022.1	5828.9	3.20
4	0.188	4127.7	4038.9	2.15
5	0.231	2832.4	2882.2	-1.75
6	0.291	1927.2	1944.9	-0.916
7	0.365	1301.9	1306.5	-0.351
8	0.452	869.4	877.1	-0.886
9	0.570	572.2	563.8	1.46
10	0.712	371.9	362.5	2.51
11	0.871	238.0	241.3	-1.39
12	1.08	149.4	154.8	-3.65

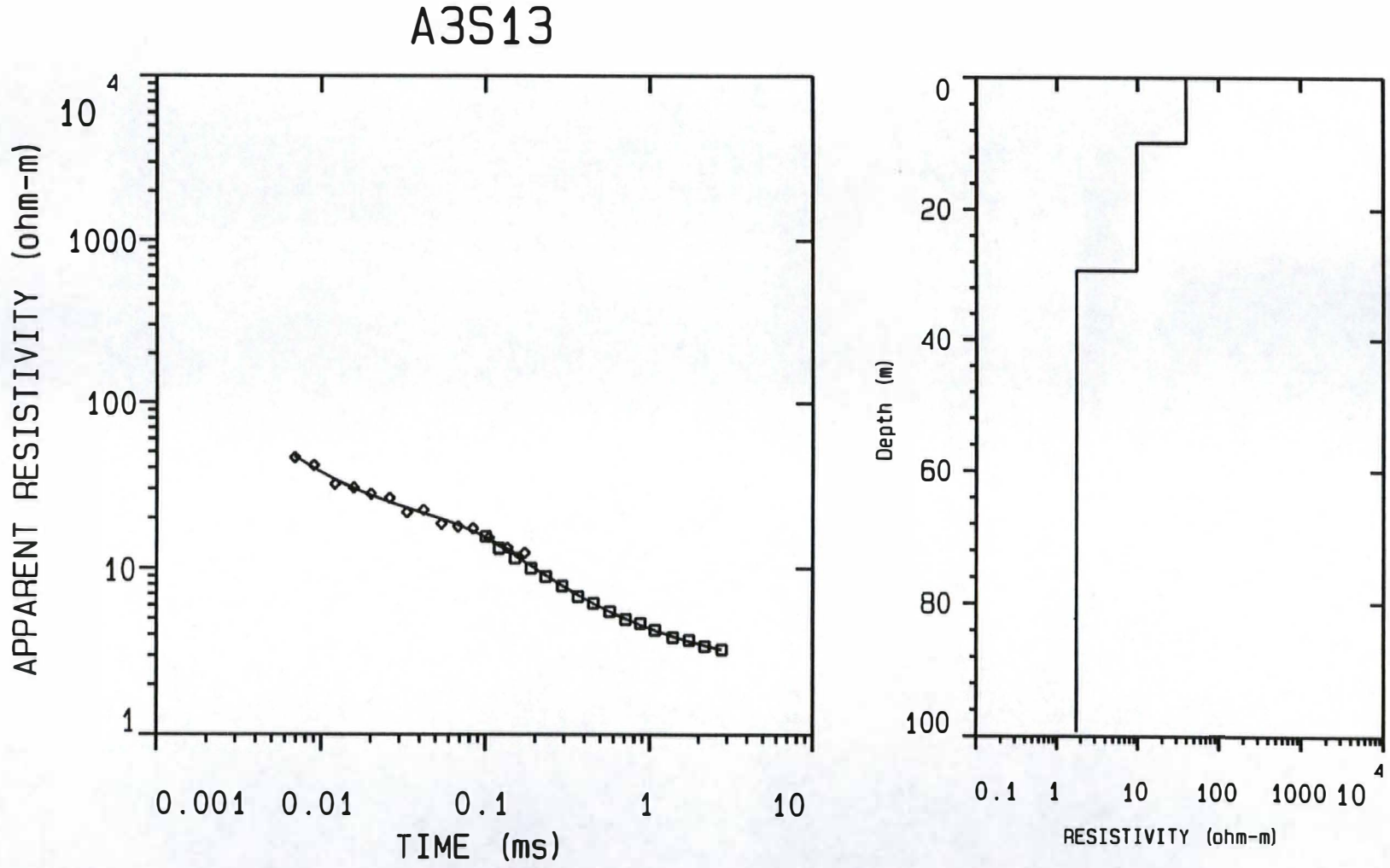
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	1.39	92.18	90.91	1.37
14	1.75	55.51	55.23	0.506
15	2.18	33.59	34.04	-1.34
16	2.78	19.65	19.55	0.479
17	3.52	11.71	11.30	3.49
18	4.39	6.44	6.63	-2.92

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
19	0.0120	861429.5	861861.5	-0.0501
20	0.0157	607906.3	611211.1	-0.543
21	0.0200	415662.4	418862.3	-0.769
22	0.0261	263563.6	258235.7	2.02
23	0.0334	157172.4	155800.1	0.873
24	0.0421	90483.0	92617.9	-2.35
25	0.0541	51025.6	50836.7	0.370
26	0.0682	29839.0	29036.0	2.69
27	0.0838	17561.7	17959.7	-2.26
28	0.104	10602.4	11151.0	-5.17
29	0.135	6574.1	6763.7	-2.88

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	P 4	T 1	T 2	T 3
P 1	0.02						
P 2	0.00	0.98					
P 3	0.00	0.00	0.99				
P 4	0.00	0.00	0.00	0.00			
T 1	0.07	0.05	0.01	0.00	0.82		
T 2	-0.01	0.00	0.01	0.00	0.00	0.99	
T 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00


A3S13
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A3S13

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 17.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 180.0000 N: 1000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.727 PERCENT
SMOOTH MODEL FITTING ERROR: 5.162 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			17.00	
1	39.40	9.85	7.14	0.250
2	9.83	19.44	-12.29	1.97
3	1.77	128.2	-140.5	72.04
4	11.64			

ALL PARAMETERS ARE FREE

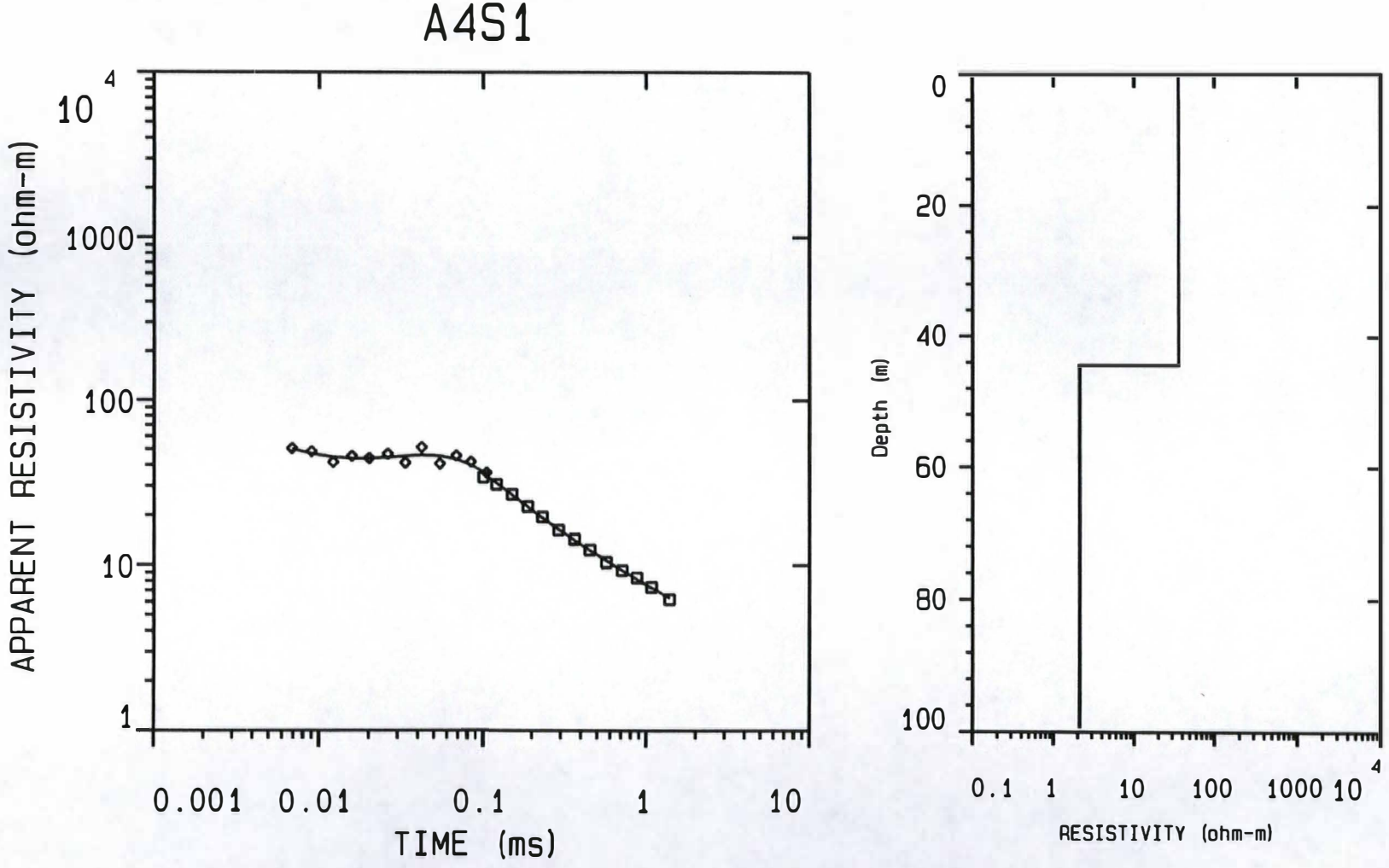
CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	4709.1	4904.4	-4.14
2	0.121	3723.9	3558.1	4.45
3	0.151	2627.9	2491.4	5.19
4	0.188	1861.5	1771.1	4.85
5	0.231	1318.0	1288.0	2.27
6	0.291	906.7	896.3	1.14
7	0.365	635.8	620.6	2.39
8	0.452	429.8	432.2	-0.563
9	0.570	286.4	287.1	-0.251
10	0.712	192.0	190.7	0.685
11	0.871	126.3	130.1	-3.00
12	1.08	84.30	85.47	-1.39

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	1.39	52.45	51.52	1.77
14	1.75	31.27	32.06	-2.52
15	2.18	20.45	20.17	1.34
16	2.78	11.97	11.92	0.408

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
17	0.00685	739328.3	721655.1	2.39
18	0.00895	444850.0	473372.6	-6.41
19	0.0120	310676.9	283710.9	8.67
20	0.0157	173844.5	175981.6	-1.22
21	0.0200	107491.4	110833.4	-3.10
22	0.0261	60194.6	65715.2	-9.17
23	0.0334	44118.2	40081.9	9.14
24	0.0421	23498.6	25151.6	-7.03
25	0.0541	16736.5	15175.9	9.32
26	0.0682	9942.2	9647.9	2.96
27	0.0838	6176.8	6545.2	-5.96


A4S1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A4S1

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 8.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 120.0000 N: 3000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 7.396 PERCENT
SMOOTH MODEL FITTING ERROR: 7.156 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			8.00	
1	36.10	44.39	-36.39	1.22
2	2.12			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 6 RAMP TIME: 2.00 muSEC

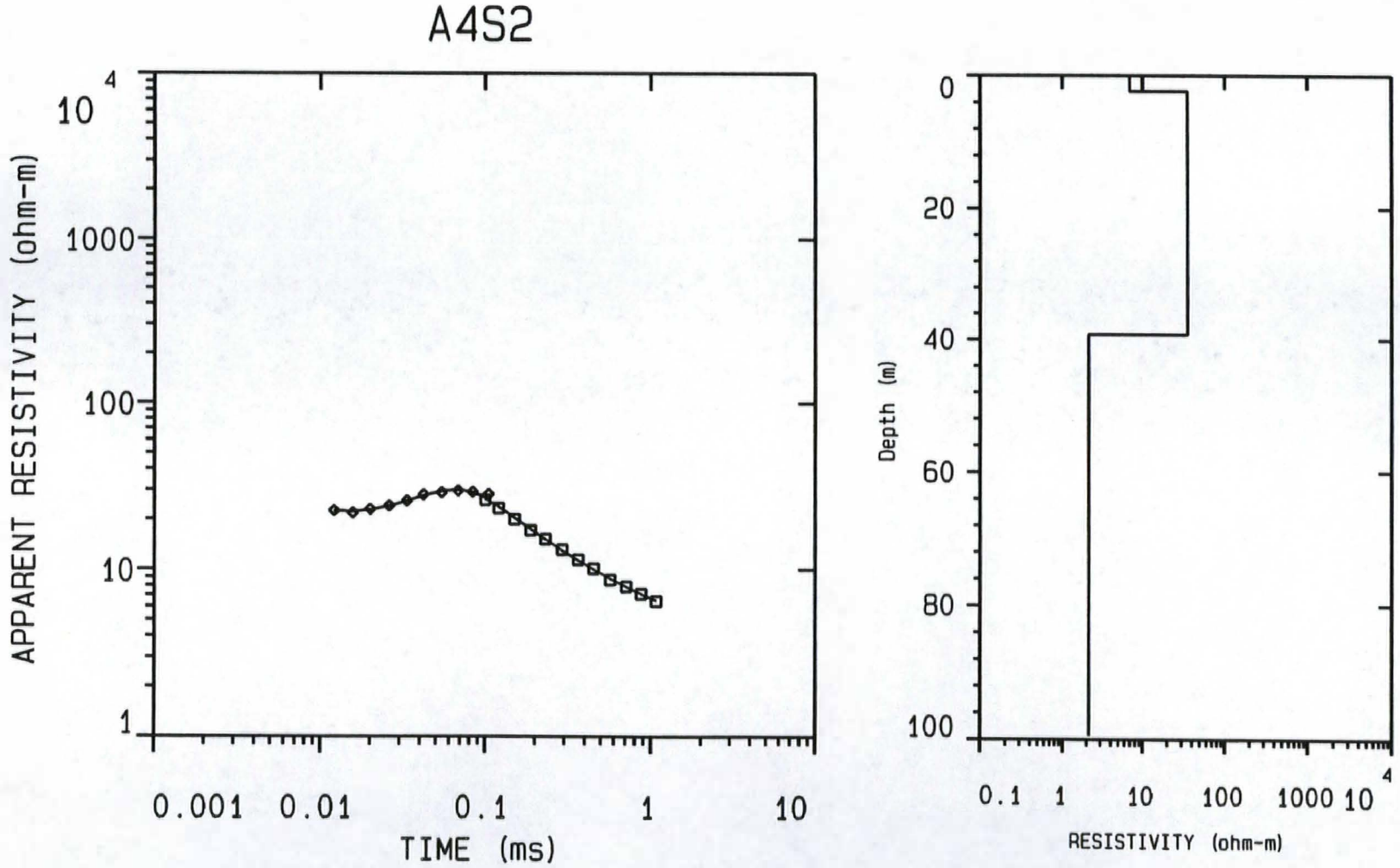
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	1455.5	1348.5	7.35
2	0.121	1045.8	1015.6	2.88
3	0.151	742.5	745.2	-0.361
4	0.188	549.6	552.2	-0.473
5	0.231	408.5	414.8	-1.53
6	0.291	304.4	298.1	2.07
7	0.365	208.3	212.8	-2.15
8	0.452	152.4	153.4	-0.666
9	0.570	110.5	106.5	3.61
10	0.712	74.65	74.71	-0.0854
11	0.871	52.82	53.93	-2.09
12	1.08	37.33	37.99	-1.77
13	1.39	25.69	25.02	2.58

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.00685	647790.9	651659.9	-0.597
15	0.00895	352319.4	369331.8	-4.82
16	0.0120	209458.5	187158.4	10.64
17	0.0157	94704.4	99503.4	-5.06
18	0.0200	54055.1	54166.2	-0.205
19	0.0261	25369.1	27264.6	-7.47
20	0.0334	16508.0	14327.7	13.20
21	0.0421	6699.4	7915.3	-18.14
22	0.0541	5056.7	4288.1	15.19
23	0.0682	2390.8	2582.9	-8.03
24	0.0838	1624.5	1739.9	-7.10
25	0.104	1173.0	1197.5	-2.09

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00		
P 2	0.00	0.94	
T 1	0.00	0.01	1.00
	P 1	P 2	T 1


A4S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A4S2

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 7.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 90.0000 N: 3000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.564 PERCENT
SMOOTH MODEL FITTING ERROR: 2.773 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			7.00	
1	6.82	2.32	4.67	0.340
2	35.78	36.89	-32.22	1.03
3	2.13			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

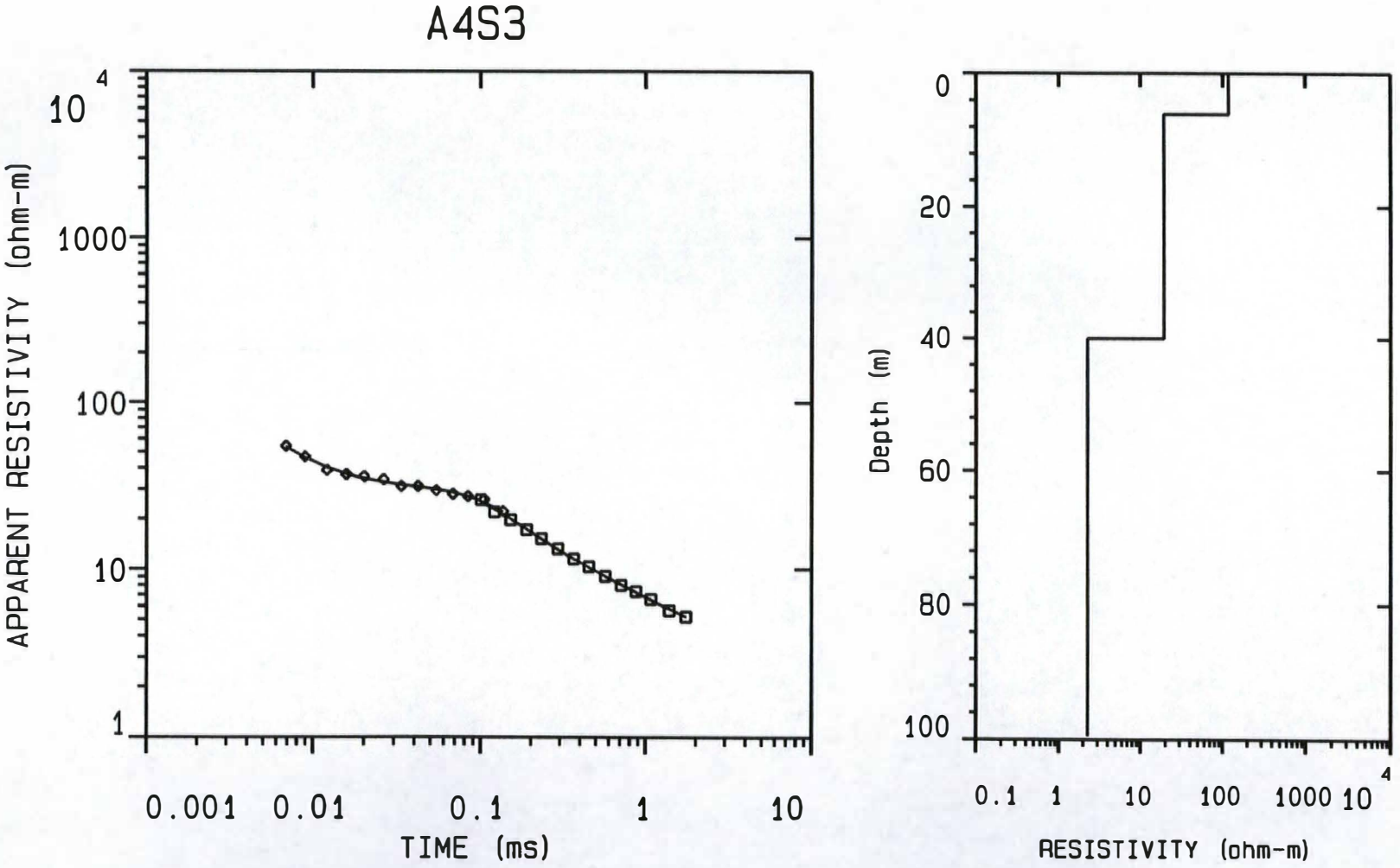
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	2144.4	2103.7	1.89
2	0.121	1585.1	1535.3	3.13
3	0.151	1142.3	1112.2	2.63
4	0.188	836.9	810.5	3.14
5	0.231	595.4	600.9	-0.927
6	0.291	420.6	423.6	-0.718
7	0.365	293.0	297.1	-1.40
8	0.452	205.4	209.4	-1.96
9	0.570	145.6	141.7	2.66
10	0.712	95.21	96.19	-1.03
11	0.871	66.76	67.09	-0.495
12	1.08	45.21	45.15	0.132

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.0120	529358.1	530282.8	-0.174
14	0.0157	285966.5	279463.7	2.27
15	0.0200	144962.2	146916.4	-1.34
16	0.0261	69149.6	69410.4	-0.377
17	0.0334	33665.5	33932.1	-0.791
18	0.0421	16649.4	17013.5	-2.18
19	0.0541	8557.7	8302.2	2.98
20	0.0682	4595.2	4506.9	1.92
21	0.0838	2822.6	2840.0	-0.615
22	0.104	1697.7	1868.5	-10.05

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.93				
P 2	0.03	0.92			
P 3	0.02	-0.03	0.93		
T 1	-0.04	-0.04	0.00	0.90	
T 2	0.00	0.01	0.01	0.01	0.99


A4S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A4S3

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 6.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 60.0000 N: 3000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.856 PERCENT
SMOOTH MODEL FITTING ERROR: 3.028 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			6.00	
1	117.0	6.05	-0.0558	0.0517
2	19.08	33.93	-33.98	1.77
3	2.27			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	2163.0	2297.9	-6.23
2	0.121	1736.9	1646.1	5.22
3	0.151	1164.9	1152.2	1.09
4	0.188	833.3	821.4	1.42
5	0.231	598.0	599.4	-0.230
6	0.291	413.5	417.4	-0.946
7	0.365	288.2	289.0	-0.265
8	0.452	199.0	202.0	-1.49
9	0.570	135.5	135.7	-0.153
10	0.712	93.57	92.18	1.47
11	0.871	63.83	64.79	-1.50
12	1.08	43.82	44.47	-1.48
13	1.39	29.38	28.53	2.88

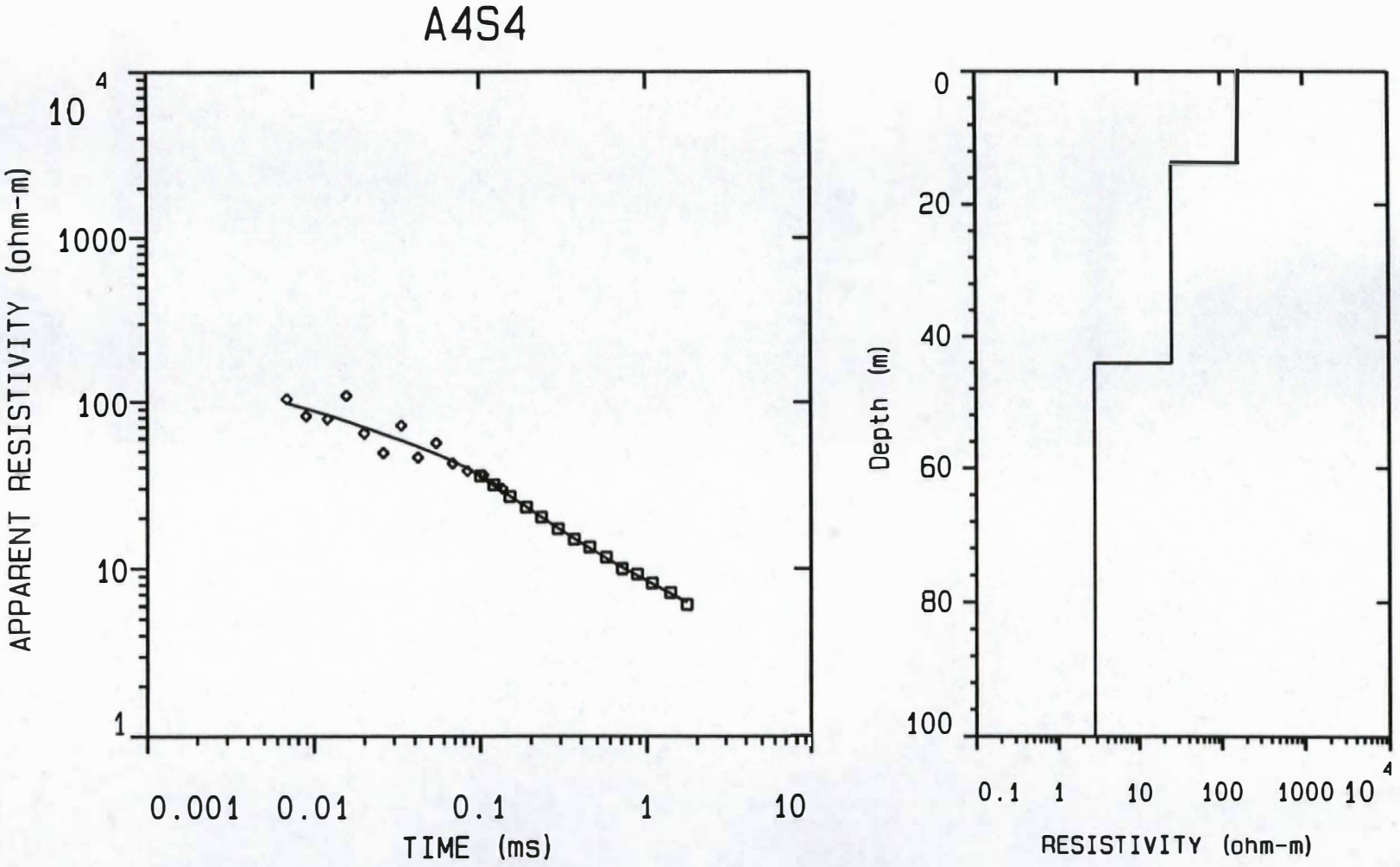
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	18.67	18.94	-1.46

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	0.00685	583149.3	591608.3	-1.45
16	0.00895	372262.0	379090.3	-1.83
17	0.0120	232770.7	219015.5	5.90
18	0.0157	131193.3	129472.2	1.31
19	0.0200	74437.1	77456.1	-4.05
20	0.0261	40847.9	42922.8	-5.07
21	0.0334	25332.4	24582.5	2.96
22	0.0421	14201.2	14398.5	-1.38
23	0.0541	8284.2	8108.5	2.12
24	0.0682	5012.3	4827.6	3.68
25	0.0838	3137.3	3142.6	-0.167
26	0.104	1924.7	2044.1	-6.20
27	0.135	1289.3	1299.4	-0.786

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.05				
P 2	0.00	0.98			
P 3	0.01	-0.01	0.97		
T 1	0.18	0.03	0.01	0.89	
T 2	-0.04	0.00	0.01	0.01	0.99
	P 1	P 2	P 3	T 1	T 2


A4S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A4S4

CLIENT: Lanai Water Company
DATE: 8-17-01
LOCATION: Area 3
SOUNDING: 2
COUNTY: Maui
ELEVATION: 8.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 30.0000 N: 3000.0000
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 19.111 PERCENT
SMOOTH MODEL FITTING ERROR: 17.524 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			8.00	
1	161.0	13.86	-5.86	0.0861
2	25.18	30.22	-36.09	1.20
3	2.81			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS
EM-47
COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz
GAIN: 7
RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	1336.9	1373.2	-2.71
2	0.121	995.3	1015.1	-1.98
3	0.151	730.4	723.1	0.999
4	0.188	527.5	521.6	1.11
5	0.231	386.1	384.3	0.466
6	0.291	276.1	272.2	1.39
7	0.365	195.1	192.5	1.35
8	0.452	135.1	137.6	-1.83
9	0.570	92.58	94.52	-2.09
10	0.712	67.22	65.33	2.80
11	0.871	45.42	46.46	-2.27
12	1.08	31.87	32.19	-0.992
13	1.39	20.51	20.88	-1.79

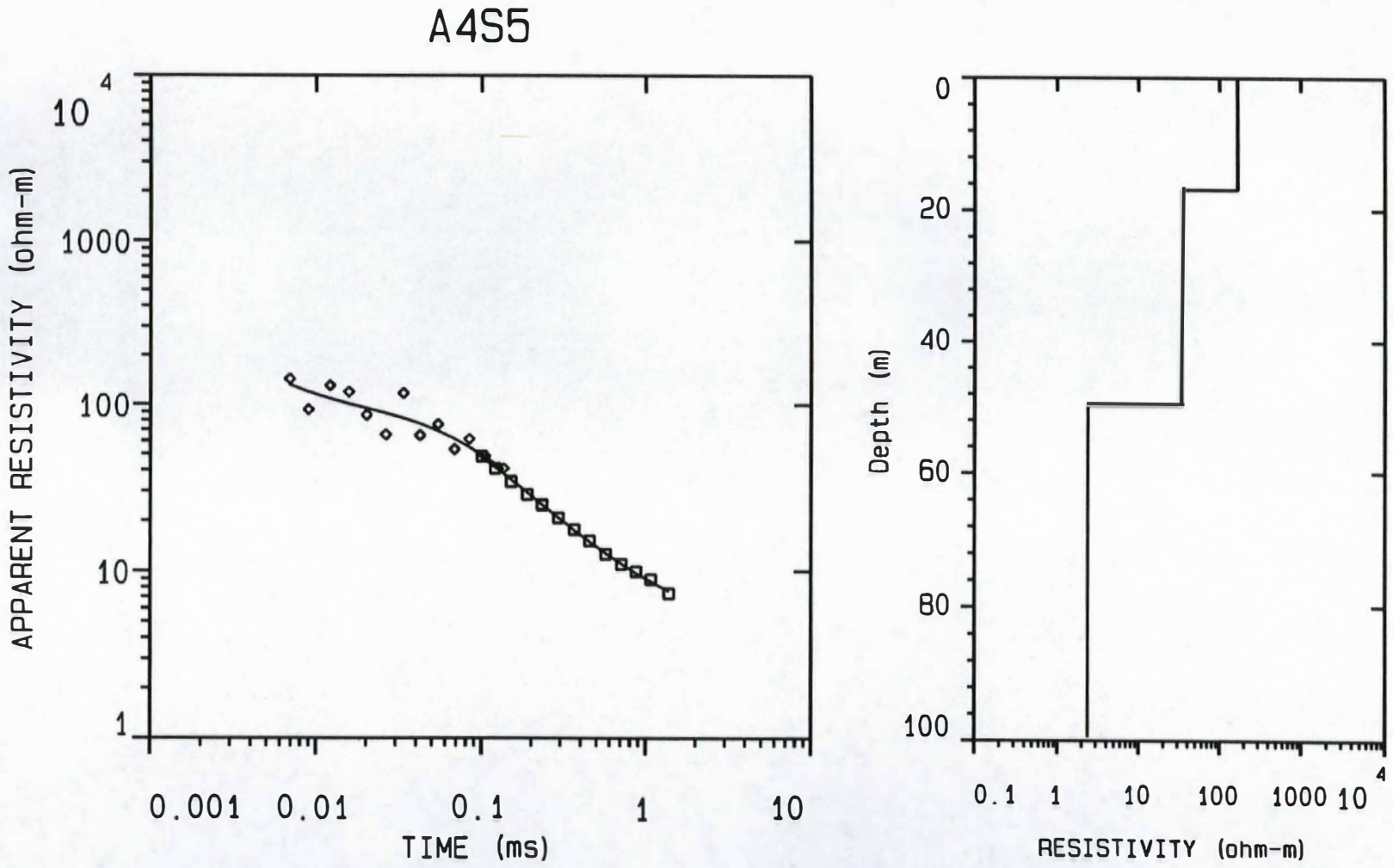
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	1.75	14.76	14.03	4.91

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 1 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	0.00685	219574.8	238619.1	-8.67
16	0.00895	160579.9	137254.4	14.52
17	0.0120	80668.2	74175.9	8.04
18	0.0157	25589.9	43661.4	-70.61
19	0.0200	30649.7	26980.1	11.97
20	0.0261	23591.1	15993.6	32.20
21	0.0334	7248.8	9882.2	-36.32
22	0.0421	7941.8	6326.2	20.34
23	0.0541	3129.6	3925.8	-25.44
24	0.0682	2684.5	2567.8	4.34
25	0.0838	1877.2	1784.3	4.94
26	0.104	1172.4	1225.1	-4.49
27	0.135	813.8	801.7	1.49

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.10				
P 2	-0.06	0.95			
P 3	0.01	-0.01	0.97		
T 1	0.23	0.05	0.00	0.91	
T 2	-0.10	-0.02	0.01	0.04	0.98


A4S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A4S5

CLIENT: Lanai Water Company DATE: 8-17-01
LOCATION: Area 3 SOUNDING: 2
COUNTY: Maui ELEVATION: 15.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 0.0000 N: 3000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 21.784 PERCENT
SMOOTH MODEL FITTING ERROR: 21.069 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			15.00	
1	165.9	16.88	-1.88	0.101
2	34.02	32.86	-34.74	0.965
3	2.39			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

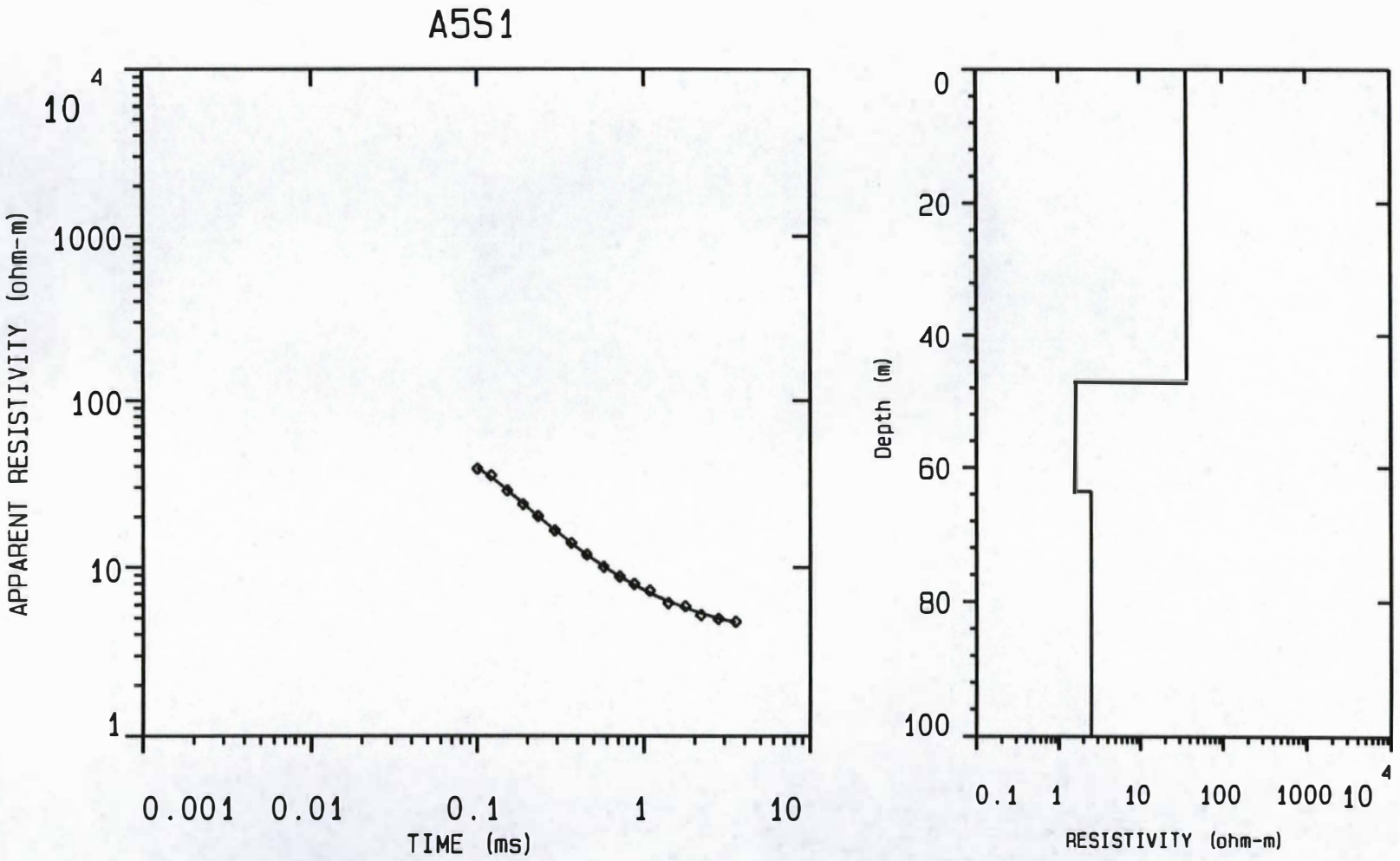
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	845.7	868.6	-2.70
2	0.121	675.3	661.9	1.98
3	0.151	509.5	490.7	3.69
4	0.188	383.1	368.7	3.77
5	0.231	284.7	282.3	0.854
6	0.291	210.3	208.3	0.941
7	0.365	151.9	153.3	-0.903
8	0.452	111.9	113.6	-1.51
9	0.570	82.34	80.95	1.68
10	0.712	58.10	57.68	0.727
11	0.871	40.69	41.92	-3.02
12	1.08	28.16	29.43	-4.53
13	1.39	19.99	19.10	4.44

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.00685	137030.8	154046.4	-12.41
15	0.00895	133623.0	91715.1	31.36
16	0.0120	37952.0	49920.0	-31.53
17	0.0157	22428.1	28872.4	-28.73
18	0.0200	19982.3	17264.8	13.59
19	0.0261	15381.7	9851.1	35.95
20	0.0334	3499.1	5913.5	-69.00
21	0.0421	4755.2	3737.8	21.39
22	0.0541	2024.9	2320.2	-14.58
23	0.0682	1901.8	1534.9	19.29
24	0.0838	919.2	1086.3	-18.18
25	0.104	753.9	765.8	-1.57
26	0.135	508.4	521.1	-2.48

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.20				
P 2	-0.10	0.93			
P 3	0.02	-0.01	0.96		
T 1	0.31	0.08	0.00	0.84	
T 2	-0.16	-0.04	0.01	0.08	0.96


A5S1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A5S1

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 5 -Haua Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 28.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 0.0000 N: 4000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 2.347 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			28.00	
1	36.81	46.98	-18.98	1.27
2	1.60	16.62	-35.60	10.35
3	2.50			

ALL PARAMETERS ARE FREE

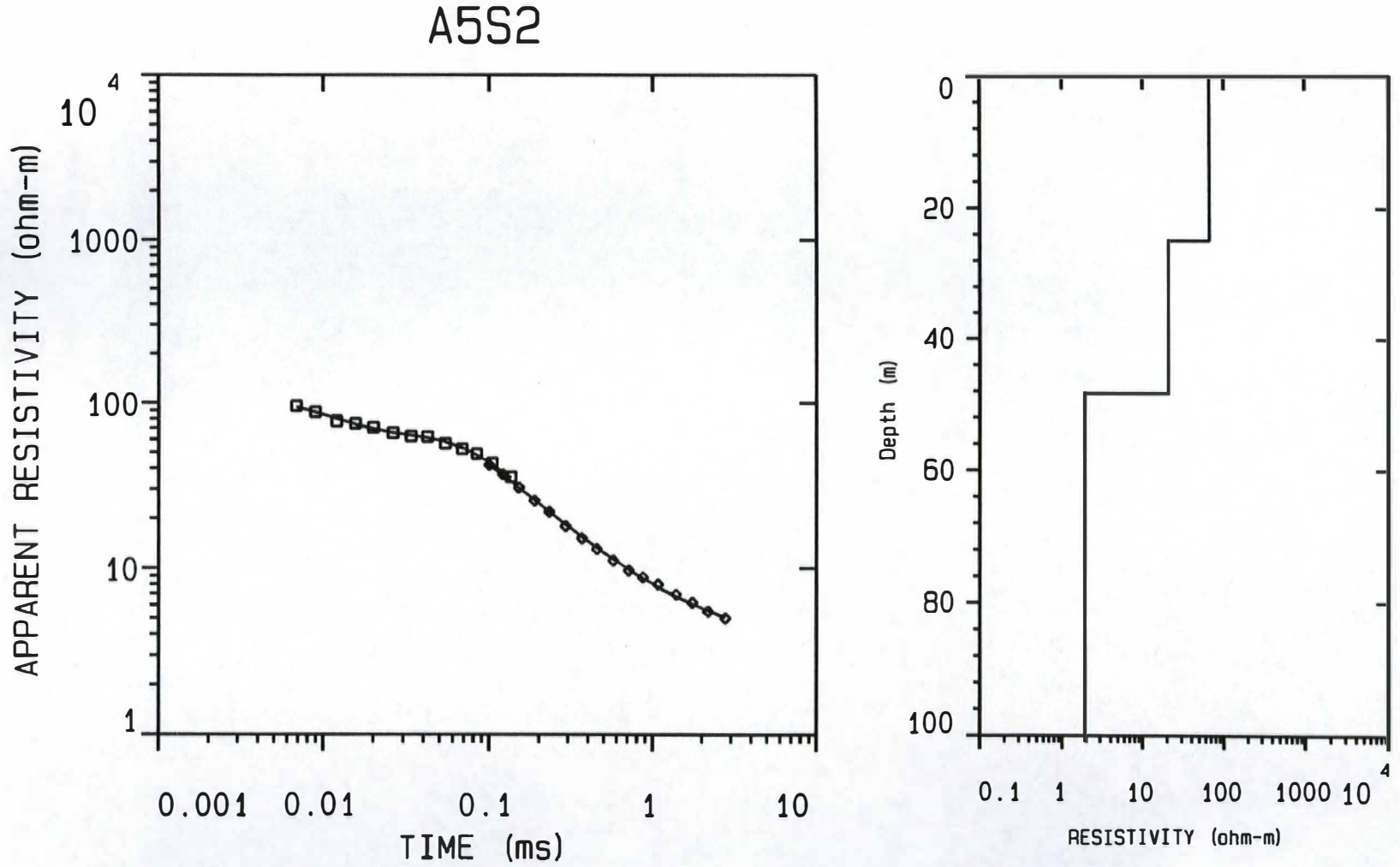
CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.100	1186.2	1163.1	1.94
2	0.121	841.5	875.7	-4.05
3	0.151	666.5	657.7	1.32
4	0.188	509.2	503.1	1.18
5	0.231	388.8	391.3	-0.643
6	0.291	293.8	292.5	0.423
7	0.365	216.7	217.1	-0.175
8	0.452	160.3	160.8	-0.286
9	0.570	116.3	114.1	1.88
10	0.712	81.13	80.40	0.899
11	0.871	56.83	57.64	-1.41
12	1.08	37.92	39.67	-4.61
13	1.39	25.99	25.05	3.60
14	1.75	15.63	16.13	-3.19

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
15	2.18	10.84	10.42	3.78
16	2.78	6.33	6.29	0.637
17	3.52	3.72	3.78	-1.54

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.75				
P 2	-0.14	0.81			
P 3	0.06	0.05	0.79		
T 1	0.05	0.04	-0.02	0.99	
T 2	-0.12	-0.26	-0.15	0.04	0.18
	P 1	P 2	P 3	T 1	T 2


A5S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A5S2

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 5- Haua Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 26.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 30.0000 N: 4000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 2.724 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			26.00	
1	66.71	24.93	1.06	0.373
2	20.63	23.39	-22.33	1.13
3	1.95			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

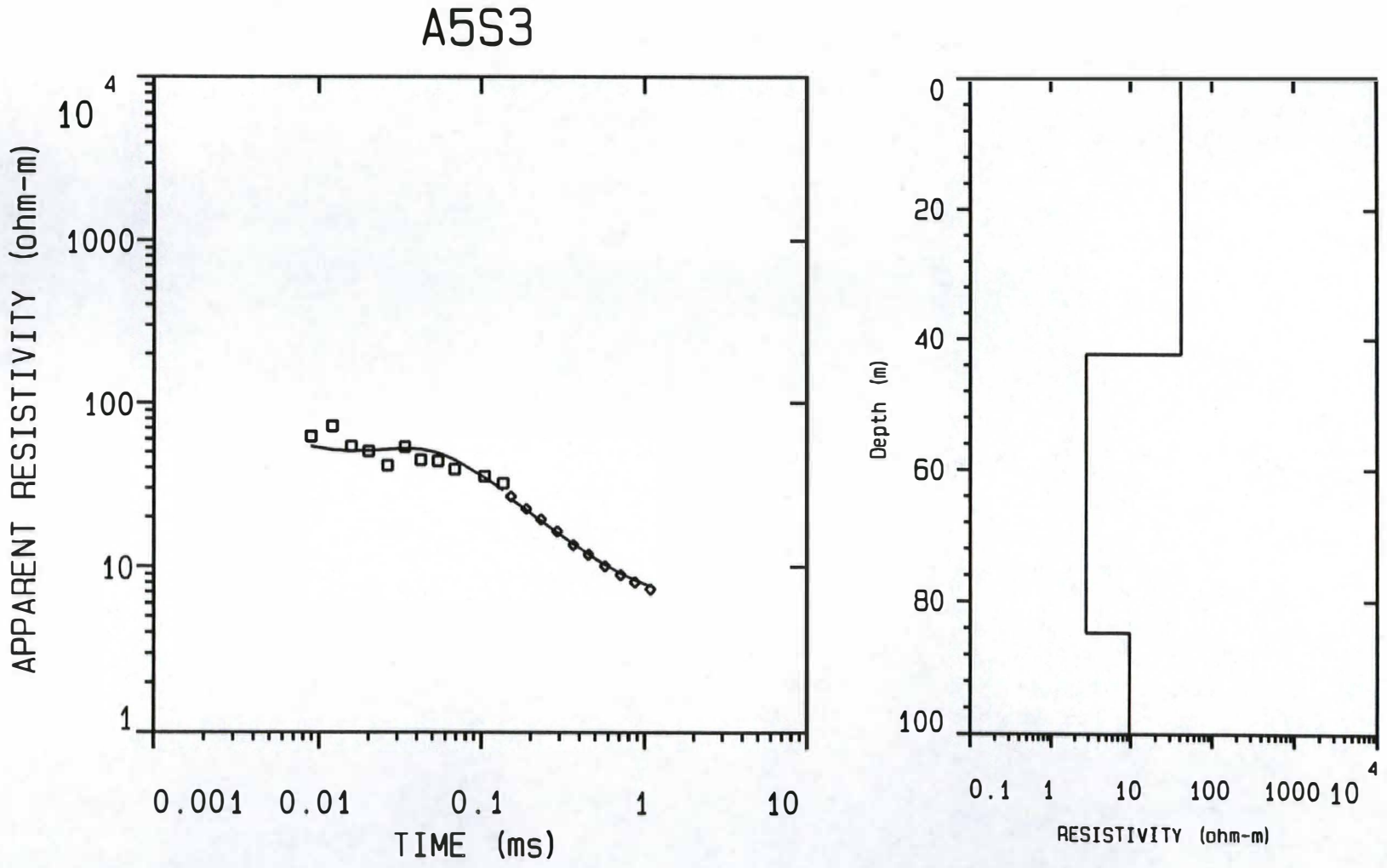
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	250787.7	254496.4	-1.47
2	0.00895	144874.2	146003.0	-0.779
3	0.0120	82864.9	78753.0	4.96
4	0.0157	45130.6	45878.4	-1.65
5	0.0200	26619.9	27493.7	-3.28
6	0.0261	15411.5	15320.1	0.592
7	0.0334	8915.3	8764.0	1.69
8	0.0421	5086.5	5173.4	-1.70
9	0.0541	3123.9	3016.7	3.43
10	0.0682	1961.6	1908.9	2.68
11	0.0838	1293.2	1335.5	-3.27
12	0.104	908.1	941.4	-3.67
13	0.135	630.2	643.9	-2.17

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	1056.2	1066.8	-1.00
15	0.121	798.7	812.5	-1.72
16	0.151	606.1	605.5	0.0948
17	0.188	459.0	453.5	1.20
18	0.231	345.5	345.9	-0.108
19	0.291	261.9	253.7	3.10
20	0.365	192.1	185.6	3.37
21	0.452	140.8	136.8	2.87
22	0.570	100.3	97.04	3.30
23	0.712	70.60	68.90	2.40
24	0.871	49.17	49.92	-1.50
25	1.08	33.05	34.95	-5.74
26	1.39	21.81	22.59	-3.60
27	1.75	14.51	14.92	-2.84
28	2.18	10.03	9.89	1.40
29	2.78	6.29	6.15	2.23

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.98				
P 2	-0.04	0.66			
P 3	0.00	-0.02	0.97		
T 1	0.03	0.19	0.01	0.88	
T 2	-0.03	-0.17	0.00	0.11	0.89


A5S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A5S3

CLIENT: Lanai Water Company
LOCATION: Area 5- Haua Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 60.0000 N: 4000.0000

DATE: 8018-01
SOUNDING: 2
ELEVATION: 26.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 17.814 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			26.00	
1	41.07	42.28	-16.28	1.02
2	2.76	42.47	-58.76	15.33
3	9.61			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00895	244766.8	300067.3	-22.59
2	0.0120	93264.1	152874.5	-63.91
3	0.0157	73050.3	80992.2	-10.87
4	0.0200	44488.8	43878.2	1.37
5	0.0261	30571.7	21902.4	28.35
6	0.0334	11280.1	11584.0	-2.69
7	0.0421	8349.1	6627.9	20.61
8	0.0541	4561.2	3836.1	15.89
9	0.0682	3023.1	2479.4	17.98
10	0.104	1216.8	1248.4	-2.60
11	0.135	738.2	850.3	-15.18

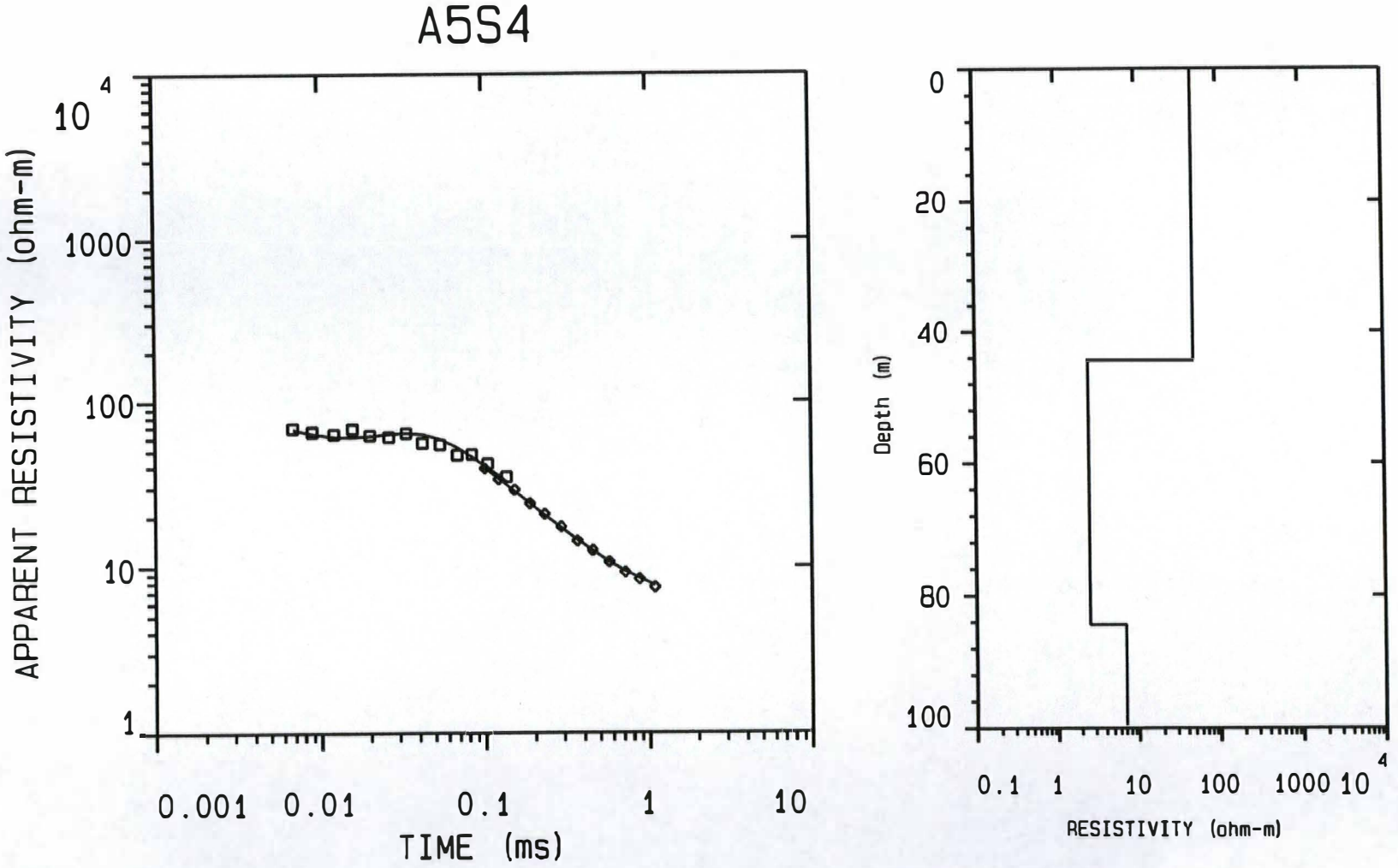
CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.

FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
12	0.151	744.6	780.5	-4.82
13	0.188	557.8	572.6	-2.65
14	0.231	416.8	428.6	-2.83
15	0.291	301.8	308.2	-2.13
16	0.365	227.6	222.0	2.45
17	0.452	162.9	161.3	1.00
18	0.570	115.8	111.9	3.38
19	0.712	80.15	77.23	3.65
20	0.871	56.19	53.80	4.24
21	1.08	37.89	35.74	5.67

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	0.00	0.96			
P 3	0.00	-0.05	0.02		
T 1	0.00	0.01	0.00	1.00	
T 2	0.00	0.00	-0.06	0.01	0.52
	P 1	P 2	P 3	T 1	T 2


A5S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A5S4

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 5- Haua Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 29.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 90.0000 N: 4000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 7.611 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			29.00	
1	49.16	44.39	-15.39	0.903
2	2.52	40.00	-55.40	15.83
3	6.95			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	406569.3	415600.7	-2.22
2	0.00895	223334.2	233517.4	-4.55
3	0.0120	110853.3	117046.0	-5.58
4	0.0157	51518.3	61133.7	-18.66
5	0.0200	32103.0	32589.3	-1.51
6	0.0261	16971.8	16044.4	5.46
7	0.0334	8478.6	8477.9	0.00814
8	0.0421	5900.6	4906.4	16.84
9	0.0541	3260.7	2908.2	10.81
10	0.0682	2264.2	1941.7	14.24
11	0.0838	1350.5	1413.1	-4.63
12	0.104	938.7	1024.4	-9.13
13	0.135	644.6	714.8	-10.87

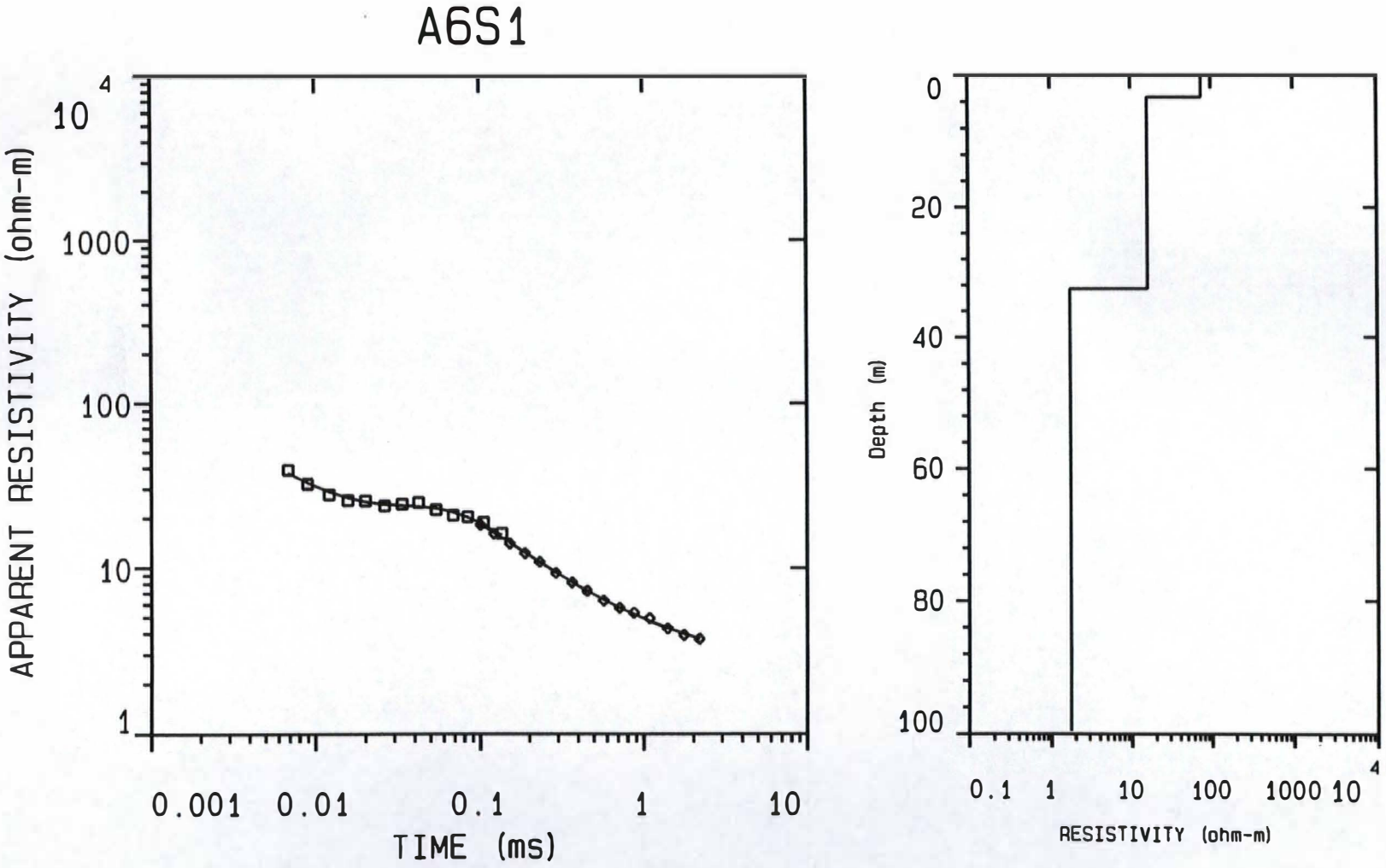
CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	1161.7	1151.2	0.903
15	0.121	903.2	893.8	1.03
16	0.151	648.0	667.6	-3.01
17	0.188	498.4	498.7	-0.0525
18	0.231	372.5	379.2	-1.78
19	0.291	273.0	276.8	-1.38
20	0.365	208.0	202.5	2.66
21	0.452	148.6	148.8	-0.0943
22	0.570	105.4	104.8	0.575
23	0.712	75.72	73.27	3.23
24	0.871	52.60	51.80	1.53
25	1.08	36.39	34.94	3.98

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	1.00				
P 2	0.00	0.95			
P 3	0.00	-0.06	0.02		
T 1	0.00	0.00	0.00	1.00	
T 2	0.00	0.02	-0.06	0.01	0.41
	P 1	P 2	P 3	T 1	T 2

```
P 1  0.00
P 2 -0.03  0.89
T 1  0.01  0.01  1.00
       P 1   P 2   T 1
```


A6S1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S1

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 6-Hauola Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 20.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 0.0000 N: 5000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.630 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			20.00	
1	75.70	3.29	16.70	0.0435
2	15.95	29.27	-12.56	1.83
3	1.78			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

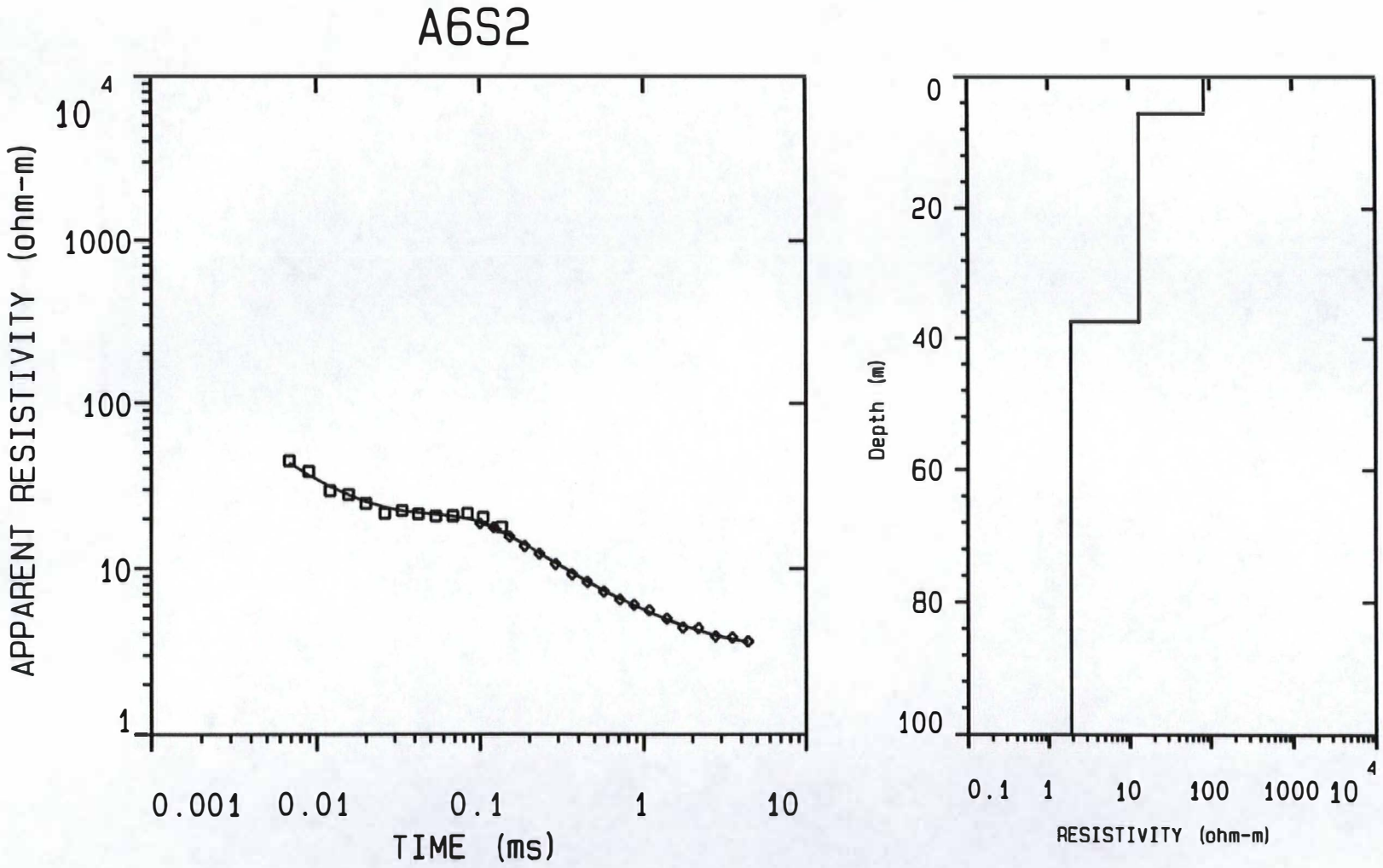
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	946242.5	1.014E+06	-7.17
2	0.00895	651917.2	638286.6	2.09
3	0.0120	385251.6	363709.6	5.59
4	0.0157	224885.5	213396.3	5.10
5	0.0200	123491.4	125898.2	-1.94
6	0.0261	70311.1	68145.4	3.08
7	0.0334	36721.9	37726.7	-2.73
8	0.0421	19986.9	21656.8	-8.35
9	0.0541	12369.0	12041.1	2.65
10	0.0682	7750.8	7315.9	5.61
11	0.0838	4795.3	4879.5	-1.75
12	0.104	3102.1	3277.9	-5.66
13	0.135	2035.8	2122.4	-4.25

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	3671.9	3666.7	0.139
15	0.121	2735.9	2676.6	2.16
16	0.151	1927.2	1890.9	1.88
17	0.188	1381.0	1350.1	2.23
18	0.231	982.2	983.6	-0.144
19	0.291	694.9	685.5	1.35
20	0.365	483.8	477.3	1.35
21	0.452	335.2	335.4	-0.0596
22	0.570	230.2	226.5	1.61
23	0.712	153.6	153.2	0.224
24	0.871	102.8	106.5	-3.60
25	1.08	67.87	71.44	-5.25
26	1.39	44.49	44.05	0.977
27	1.75	28.64	27.92	2.54
28	2.18	17.87	17.81	0.336

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.07				
P 2	0.01	0.98			
P 3	0.01	0.00	0.98		
T 1	0.19	0.06	0.01	0.72	
T 2	-0.03	0.00	0.01	0.02	0.99


A6S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S2

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 6-Hauola Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 18.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 30.0000 N: 5000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.196 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			18.00	
1	85.02	5.57	12.42	0.0655
2	13.29	31.79	-19.36	2.39
3	1.93			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

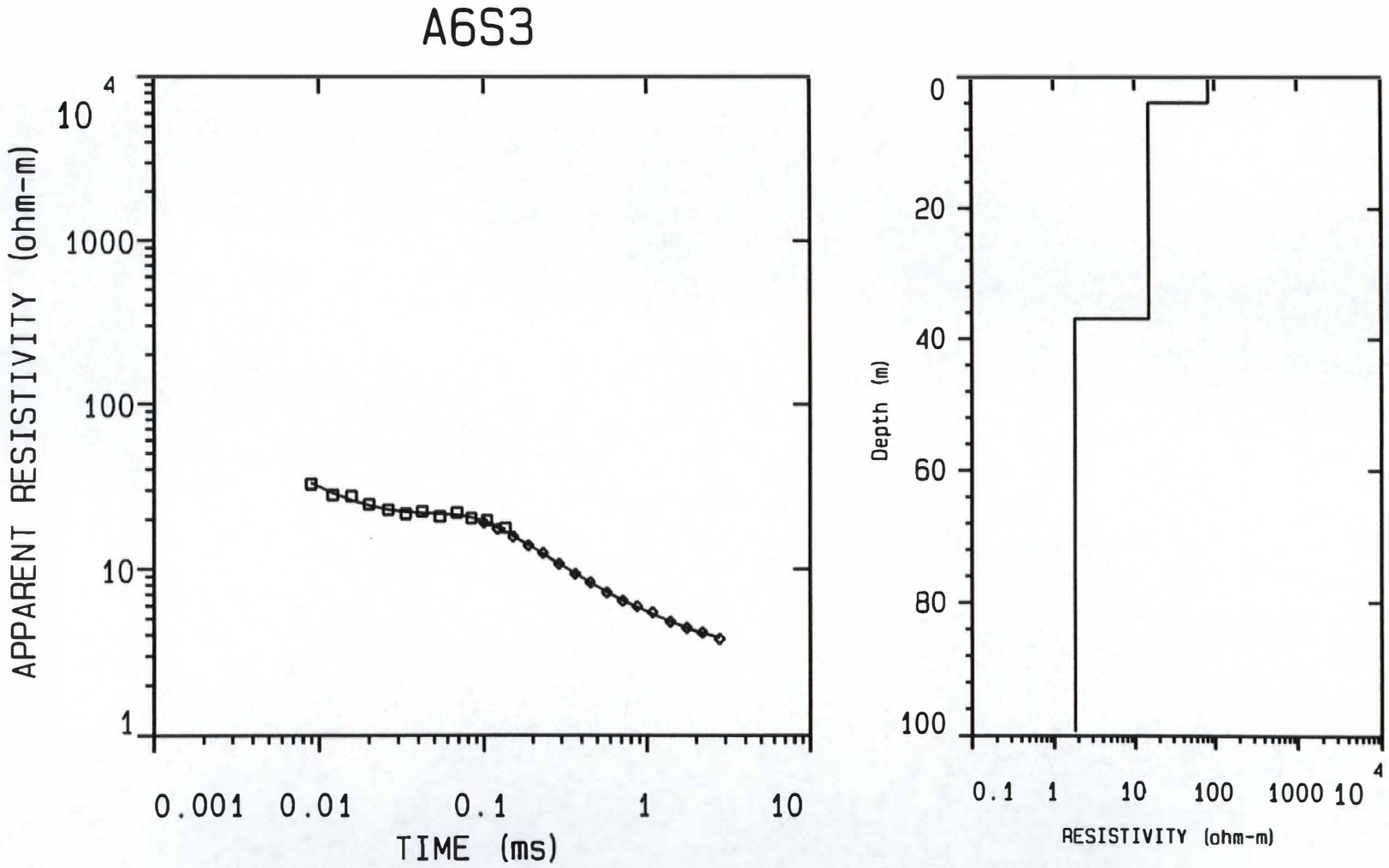
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	778755.1	820200.8	-5.32
2	0.00895	495279.7	537685.8	-8.56
3	0.0120	350409.3	322874.6	7.85
4	0.0157	198173.0	199432.0	-0.635
5	0.0200	129145.6	124434.4	3.64
6	0.0261	82032.1	71693.6	12.60
7	0.0334	41550.9	41759.0	-0.500
8	0.0421	25184.2	24554.5	2.50
9	0.0541	14155.4	13582.8	4.04
10	0.0682	7836.4	7897.2	-0.775
11	0.0838	4472.9	4972.2	-11.16
12	0.104	2780.6	3115.2	-12.03
13	0.135	1774.5	1882.5	-6.09

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	3548.9	3511.6	1.05
15	0.121	2380.1	2432.0	-2.18
16	0.151	1669.8	1633.9	2.15
17	0.188	1167.9	1130.3	3.21
18	0.231	820.4	808.0	1.50
19	0.291	572.1	557.4	2.57
20	0.365	401.0	385.8	3.77
21	0.452	274.7	271.0	1.35
22	0.570	187.5	183.1	2.32
23	0.712	127.4	124.4	2.39
24	0.871	85.56	86.85	-1.50
25	1.08	56.41	58.45	-3.61
26	1.39	35.59	36.24	-1.82
27	1.75	24.12	23.07	4.34
28	2.18	14.07	14.81	-5.21
29	2.78	9.05	8.90	1.60
30	3.52	5.15	5.34	-3.65
31	4.39	3.23	3.24	-0.519

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.04				
P 2	-0.01	0.99			
P 3	0.00	0.00	0.98		
T 1	0.18	0.03	0.00	0.91	
T 2	-0.03	0.00	0.01	0.01	0.99


A6S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S3

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 6-Hauola Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 16.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 60.0000 N: 5000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 3.029 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			16.00	
1	83.91	3.89	12.10	0.0464
2	14.82	33.02	-20.91	2.22
3	1.84			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

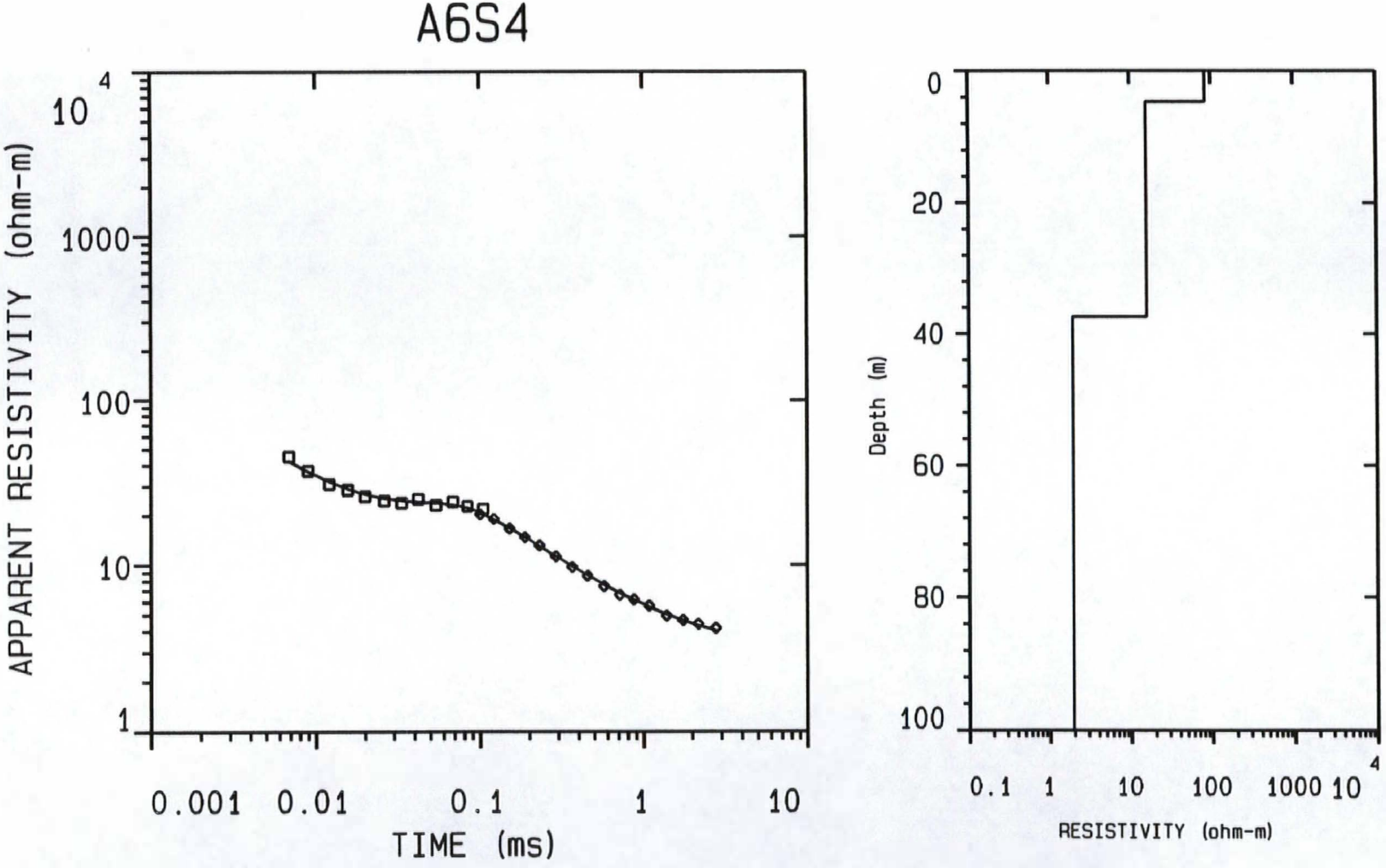
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00895	637399.5	621833.1	2.44
2	0.0120	376999.4	362030.0	3.97
3	0.0157	200037.4	217627.6	-8.79
4	0.0200	129206.7	132289.7	-2.38
5	0.0261	74406.5	74055.1	0.472
6	0.0334	43950.1	42021.5	4.38
7	0.0421	23439.0	24161.4	-3.08
8	0.0541	13888.0	13118.3	5.54
9	0.0682	7229.7	7553.2	-4.47
10	0.0838	4813.7	4751.2	1.29
11	0.104	2890.3	2991.4	-3.49
12	0.135	1769.6	1828.9	-3.35

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.100	3428.3	3375.3	1.54
14	0.121	2405.3	2354.2	2.12
15	0.151	1635.5	1600.5	2.13
16	0.188	1134.0	1117.8	1.43
17	0.231	796.2	805.7	-1.19
18	0.291	560.7	560.0	0.126
19	0.365	393.6	390.1	0.889
20	0.452	275.0	275.7	-0.252
21	0.570	189.9	186.9	1.58
22	0.712	130.0	127.7	1.83
23	0.871	88.20	89.25	-1.18
24	1.08	58.10	60.40	-3.96
25	1.39	37.66	37.55	0.295
26	1.75	24.06	23.99	0.280
27	2.18	15.25	15.44	-1.20
28	2.78	9.49	9.30	2.06

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.05				
P 2	0.00	0.98			
P 3	0.01	-0.01	0.97		
T 1	0.17	0.05	0.01	0.79	
T 2	-0.02	0.00	0.01	0.02	0.99
	P 1	P 2	P 3	T 1	T 2


A6S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S4

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 6-Hauola Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 14.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 90.0000 N: 5000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.022 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			14.00	
1	85.24	4.67	9.32	0.0548
2	15.75	32.72	-23.40	2.07
3	1.95			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

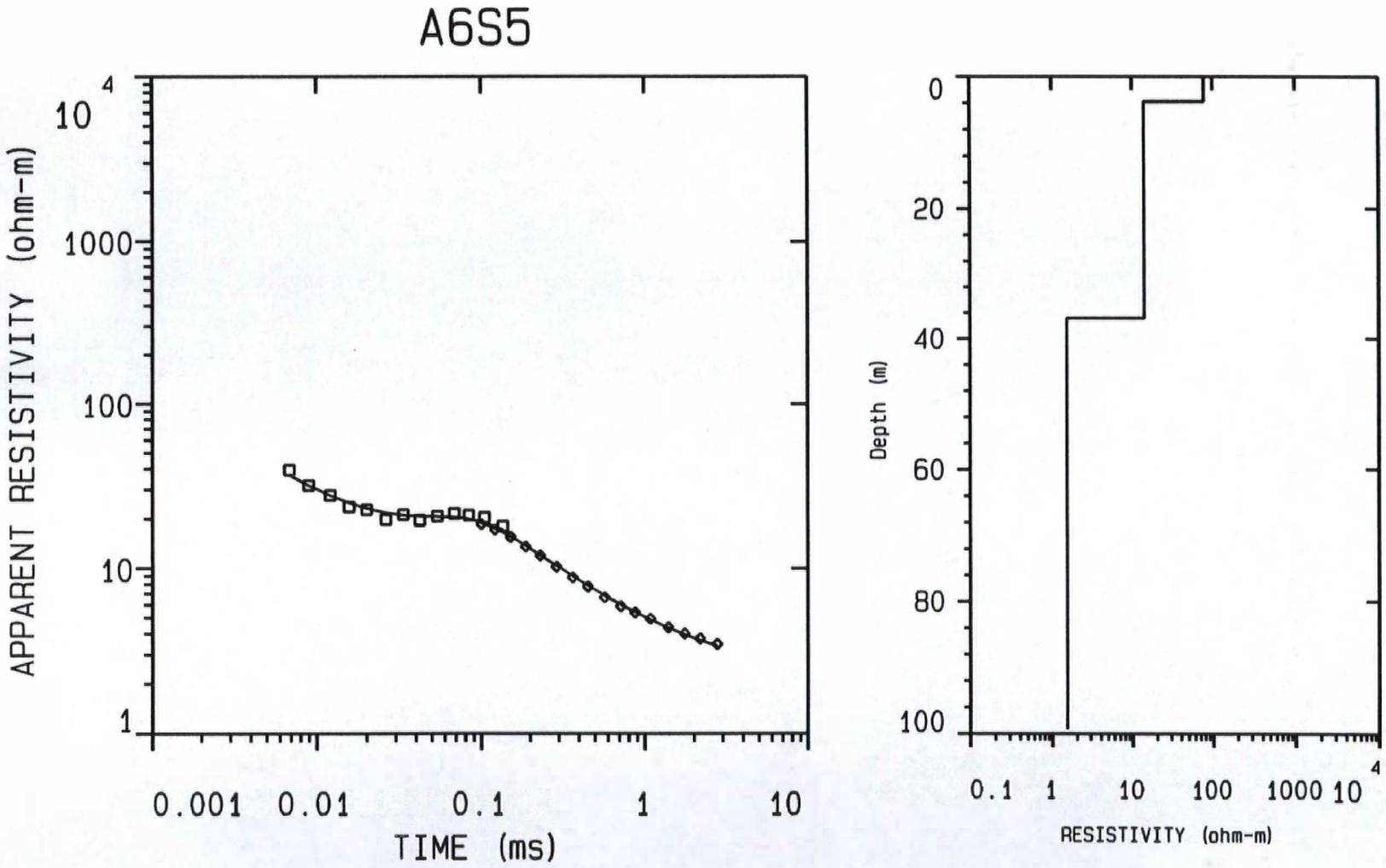
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	764390.2	836084.3	-9.37
2	0.00895	528746.6	534805.5	-1.14
3	0.0120	329626.1	312041.3	5.33
4	0.0157	191617.2	187860.3	1.96
5	0.0200	119227.8	114212.8	4.20
6	0.0261	66857.4	63879.4	4.45
7	0.0334	38051.4	36241.4	4.75
8	0.0421	19837.1	20872.2	-5.21
9	0.0541	11910.5	11415.3	4.15
10	0.0682	6276.1	6648.6	-5.93
11	0.0838	4121.4	4240.0	-2.87
12	0.104	2490.6	2710.7	-8.84

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
13	0.100	3108.8	3051.9	1.83
14	0.121	2136.4	2154.8	-0.862
15	0.151	1495.6	1479.4	1.08
16	0.188	1039.2	1040.1	-0.0884
17	0.231	738.7	752.3	-1.84
18	0.291	526.0	523.7	0.423
19	0.365	371.7	364.9	1.82
20	0.452	261.3	257.7	1.36
21	0.570	181.8	174.7	3.93
22	0.712	124.6	119.1	4.40
23	0.871	83.28	83.25	0.0305
24	1.08	55.01	56.22	-2.20
25	1.39	36.03	34.92	3.08
26	1.75	22.11	22.27	-0.714
27	2.18	13.81	14.31	-3.61
28	2.78	8.22	8.61	-4.74

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.06				
P 2	0.00	0.99			
P 3	0.00	0.00	0.98		
T 1	0.20	0.03	0.01	0.86	
T 2	-0.03	0.00	0.01	0.01	0.99


A6S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A6S5

CLIENT: Lanai Water Company
LOCATION: Area 6-Hauola Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 120.0000 N: 5000.0000

DATE: 8018-01
SOUNDING: 2
ELEVATION: 12.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.601 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			12.00	
1	78.22	3.79	8.20	0.0485
2	13.99	33.04	-24.84	2.36
3	1.50			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

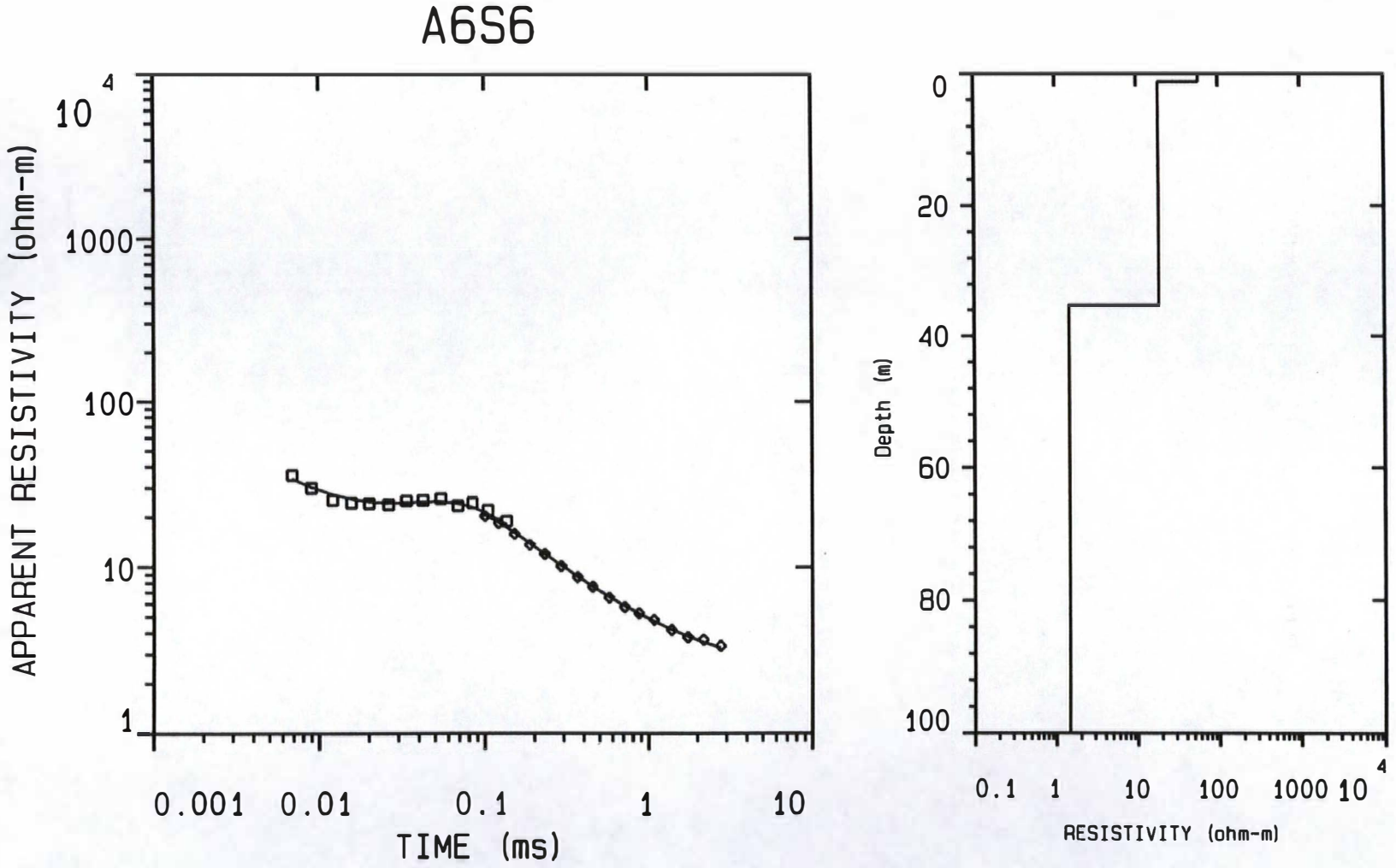
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	934628.5	1.035E+06	-10.69
2	0.00895	666129.1	664307.1	0.273
3	0.0120	384487.5	388308.6	-0.993
4	0.0157	254852.9	234574.1	7.95
5	0.0200	146276.4	143098.8	2.17
6	0.0261	92454.2	80458.4	12.97
7	0.0334	45264.3	45744.7	-1.06
8	0.0421	28734.1	26265.0	8.59
9	0.0541	14040.8	14149.7	-0.775
10	0.0682	7474.2	8045.2	-7.63
11	0.0838	4602.8	4992.3	-8.46
12	0.104	2777.7	3104.0	-11.74
13	0.135	1739.0	1881.8	-8.21

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	3584.1	3520.3	1.78
15	0.121	2504.4	2438.5	2.62
16	0.151	1662.7	1655.6	0.427
17	0.188	1177.8	1161.3	1.40
18	0.231	849.4	844.2	0.616
19	0.291	605.5	593.5	1.98
20	0.365	431.7	419.0	2.93
21	0.452	305.7	300.1	1.83
22	0.570	214.9	206.4	3.97
23	0.712	149.1	142.9	4.16
24	0.871	101.7	101.1	0.676
25	1.08	68.11	69.32	-1.78
26	1.39	43.20	43.71	-1.16
27	1.75	27.78	28.26	-1.74
28	2.18	17.69	18.39	-3.92
29	2.78	10.77	11.20	-4.03

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.05				
P 2	0.00	0.99			
P 3	0.00	-0.01	0.97		
T 1	0.18	0.04	0.01	0.84	
T 2	-0.02	0.00	0.01	0.01	1.00


A6S6
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S6

CLIENT: Lanai Water Company DATE: 8018-01
LOCATION: Area 6-Hauola Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 12.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 150.0000 N: 5000.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 5.038 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			12.00	
1	57.71	1.32	10.67	0.0229
2	18.60	33.90	-23.23	1.82
3	1.45			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

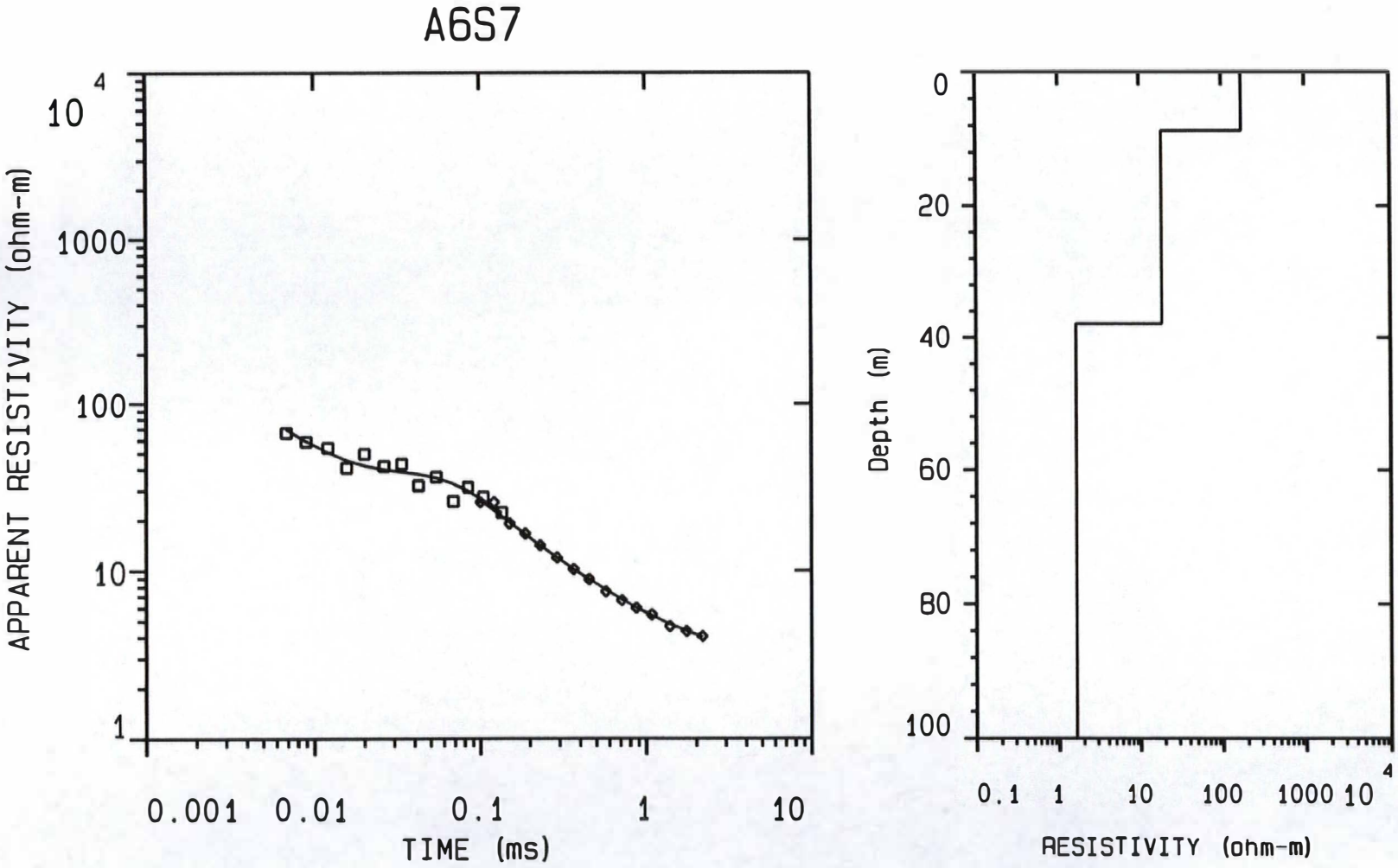
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00685	1.083E+06	1.178E+06	-8.67
2	0.00895	727408.7	715663.7	1.61
3	0.0120	442558.0	392815.2	11.23
4	0.0157	243911.2	224064.0	8.13
5	0.0200	133623.1	128986.1	3.47
6	0.0261	70448.6	67969.0	3.51
7	0.0334	35117.3	36468.3	-3.84
8	0.0421	19551.4	20216.2	-3.40
9	0.0541	10093.5	10716.1	-6.16
10	0.0682	6528.3	6250.4	4.25
11	0.0838	3684.4	4047.6	-9.85
12	0.104	2470.1	2679.1	-8.46
13	0.135	1621.5	1732.5	-6.84

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	3113.4	3025.1	2.83
15	0.121	2257.6	2202.5	2.43
16	0.151	1617.5	1571.2	2.86
17	0.188	1176.8	1140.5	3.08
18	0.231	853.0	847.3	0.660
19	0.291	614.2	605.2	1.46
20	0.365	440.1	431.8	1.87
21	0.452	313.6	311.0	0.815
22	0.570	220.0	215.3	2.12
23	0.712	154.2	149.4	3.09
24	0.871	105.9	106.1	-0.196
25	1.08	70.62	72.80	-3.08
26	1.39	46.61	45.99	1.33
27	1.75	30.35	29.78	1.88
28	2.18	18.39	19.37	-5.36
29	2.78	11.38	11.82	-3.92

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.07				
P 2	0.02	0.99			
P 3	0.01	0.00	0.97		
T 1	0.12	0.06	0.01	0.26	
T 2	-0.01	0.00	0.01	0.03	1.00
	P 1	P 2	P 3	T 1	T 2


A6S7
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A6S7

CLIENT: Lanai Water Company
LOCATION: Area 6-Hauola Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 180.0000 N: 5000.0000

DATE: 8018-01
SOUNDING: 2
ELEVATION: 20.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 12.048 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			20.00	
1	172.6	8.71	11.28	0.0504
2	18.65	29.22	-17.94	1.56
3	1.61			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

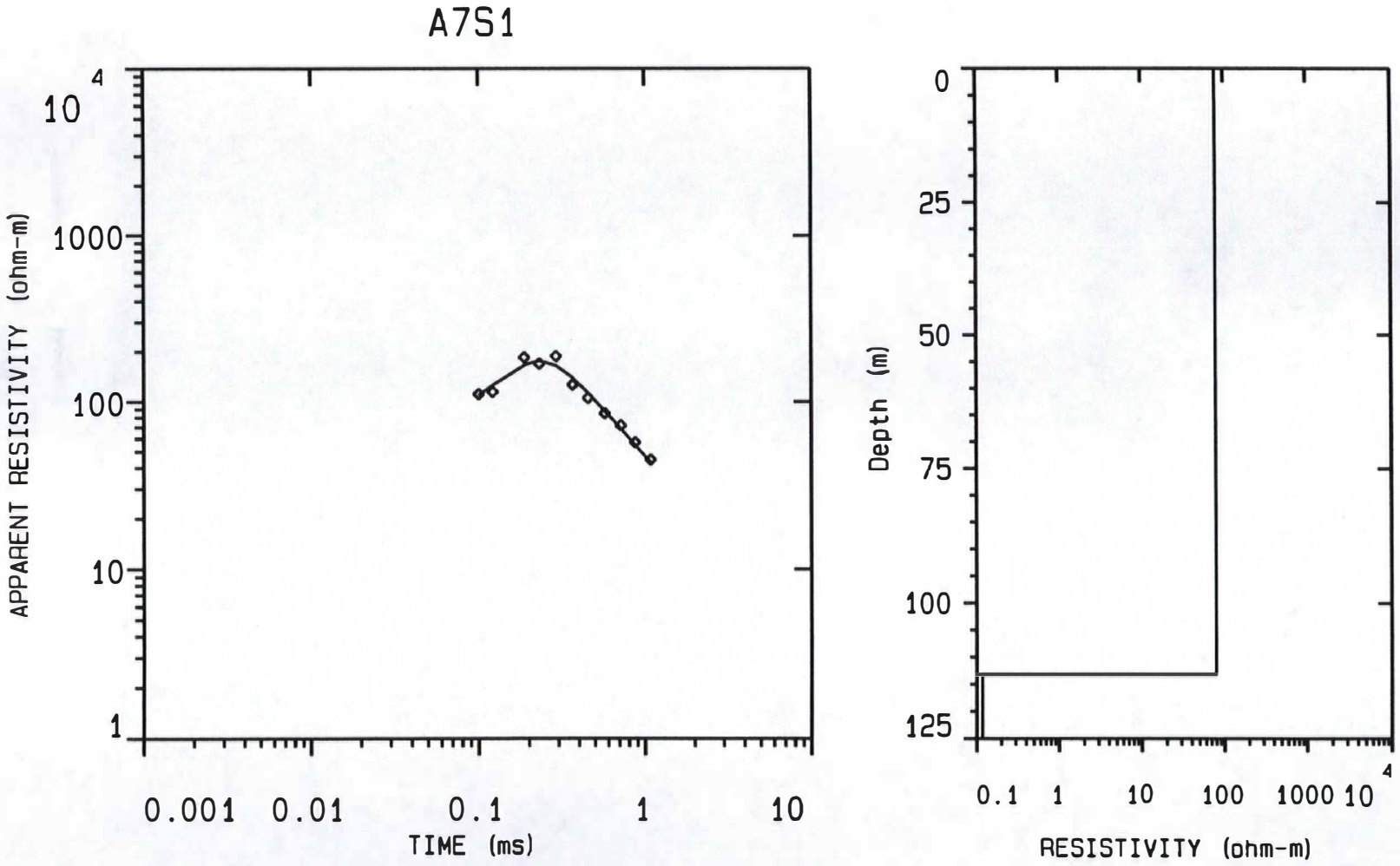
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.00685	426741.1	398991.9	6.50
2	0.00895	263891.8	261921.6	0.746
3	0.0120	141164.6	156333.5	-10.74
4	0.0157	111395.9	95205.5	14.53
5	0.0200	45321.6	57795.3	-27.52
6	0.0261	30117.9	32145.7	-6.73
7	0.0334	15463.5	18232.6	-17.90
8	0.0421	13589.6	10743.0	20.94
9	0.0541	6048.1	6194.1	-2.41
10	0.0682	5629.0	3919.7	30.36
11	0.0838	2511.9	2719.4	-8.26
12	0.104	1770.6	1904.7	-7.57
13	0.135	1274.9	1289.1	-1.11

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
14	0.100	2204.3	2141.4	2.85
15	0.121	1373.5	1621.4	-18.04
16	0.151	1223.6	1190.2	2.72
17	0.188	869.7	880.6	-1.25
18	0.231	661.2	661.9	-0.110
19	0.291	480.1	477.6	0.509
20	0.365	343.7	343.3	0.135
21	0.452	248.5	248.9	-0.160
22	0.570	179.1	173.2	3.28
23	0.712	123.2	120.8	1.95
24	0.871	86.69	86.15	0.623
25	1.08	58.44	59.33	-1.51
26	1.39	39.49	37.64	4.69
27	1.75	24.51	24.44	0.293
28	2.18	15.72	15.95	-1.49

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	P 3	T 1	T 2
P 1	0.03				
P 2	-0.02	0.97			
P 3	0.00	-0.01	0.97		
T 1	0.14	0.04	0.01	0.93	
T 2	-0.04	-0.01	0.00	0.02	0.99


A7S1
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
25
50
75
100
125
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A7S1

CLIENT: Lanai Water Company
LOCATION: Manele Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 0.0000 N: 6000.0000

DATE: 8-19-01
SOUNDING: 2
ELEVATION: 102.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 11.693 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			102.0	
1	79.40	113.2	-11.23	1.42
2	0.117			

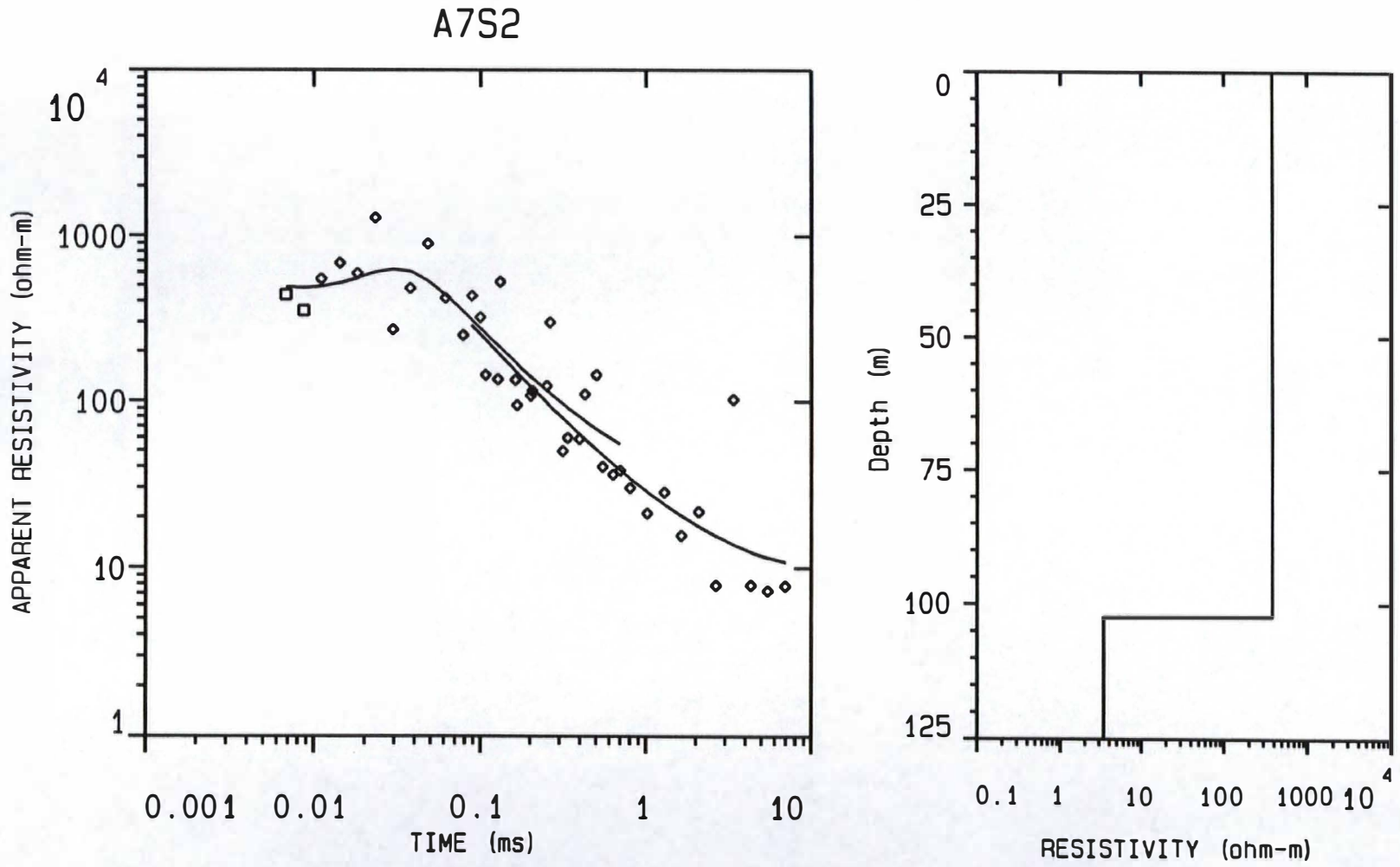
ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-47 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 6 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.100	244.5	249.7	-2.15
2	0.121	-145.7	126.2	-13.35
3	0.188	-23.70	27.62	16.50
4	0.231	-16.05	15.08	-6.00
5	0.291	-7.69	9.38	21.96
6	0.365	-7.88	6.81	-13.57
7	0.452	-6.13	5.47	-10.79
8	0.570	-4.73	4.51	-4.61
9	0.712	-3.47	3.70	6.78
10	0.871	-2.96	3.15	6.19
11	1.08	-2.49	2.62	5.08

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

```
P 1  0.98
P 2 -0.08  0.47
T 1 -0.01 -0.07  0.99
       P 1   P 2   T 1
```


A7S2
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
25
50
75
100
125
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A7S2

CLIENT: Lanai Water Company
LOCATION: Manele Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 2.0000 N: 6.0000

DATE: 8-19-01
SOUNDING: 2
ELEVATION: 101.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 129.470 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			101.0	
1	380.7	102.3	-1.39	0.268
2	3.42			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00681	25542.7	21719.6	14.96
2	0.00869	19395.4	12077.8	37.72
3	0.0110	-5530.9	6499.7	17.51
4	0.0141	-2109.5	3201.3	51.75
5	0.0180	-1425.1	1564.4	9.77
6	0.0230	-242.6	755.1	211.2
7	0.0294	-1364.5	385.9	-71.71
8	0.0375	-312.2	219.9	-29.56
9	0.0479	-66.84	145.8	118.1
10	0.0611	-113.7	106.2	-6.59
11	0.0779	-134.3	81.43	-39.37
12	0.0993	-50.54	63.68	26.00
13	0.126	-100.6	49.39	-50.91
14	0.166	-87.47	37.01	-57.68
15	0.206	-37.85	29.05	-23.25

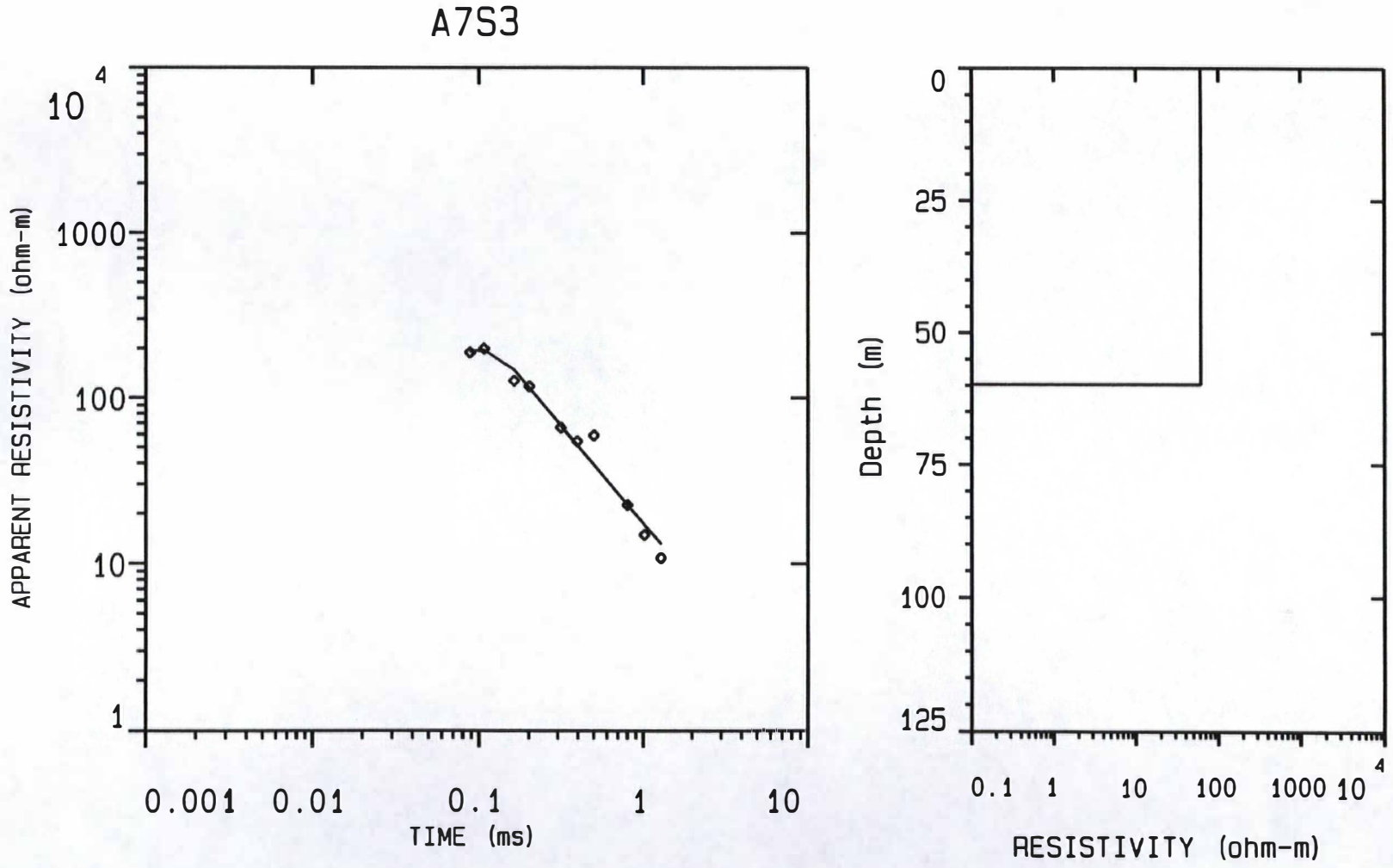
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
16	0.262	-4.93	21.80	341.5
17	0.335	-29.92	15.99	-46.56
18	0.427	-6.53	11.48	75.75
19	0.545	-16.10	8.03	-50.15
20	0.695	-9.44	5.45	-42.17

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.0881	43.50	80.32	-84.64
22	0.106	140.4	67.00	52.28
23	0.131	11.94	55.37	-363.5
24	0.161	54.92	45.57	17.02
25	0.200	44.75	36.98	17.35
26	0.250	20.95	29.67	-41.60
27	0.314	46.06	23.42	49.13
28	0.395	20.15	18.27	9.36
29	0.499	2.96	14.01	-372.5
30	0.631	13.08	10.58	19.11
31	0.799	9.58	7.85	18.08
32	1.01	8.99	5.71	36.44
33	1.28	3.20	4.08	-27.50
34	1.63	4.32	2.85	34.12
35	2.08	1.44	1.95	-35.21
36	2.64	3.58	1.30	63.64
37	3.37	-0.0416	0.847	1935.6
38	4.29	1.04	0.536	48.78
39	5.47	0.648	0.330	48.99
40	6.97	0.318	0.197	37.99

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.99		
P 2	-0.01	0.92	
T 1	0.00	0.00	1.00
	P 1	P 2	T 1


A7S3
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001 0.01 0.1 1 10
TIME (ms)
Depth (m)
0
25
50
75
100
125
0.1 1 10 100 1000 10 4
RESISTIVITY (ohm-m)

DATA SET: A7S3

CLIENT: Lanai Water Company
LOCATION: Manele Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 3.0000 N: 6.0000

DATE: 8-19-01
SOUNDING: 2
ELEVATION: 95.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 27.102 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			95.00	
1	60.37	59.79	35.20	0.990
2	0.0152			

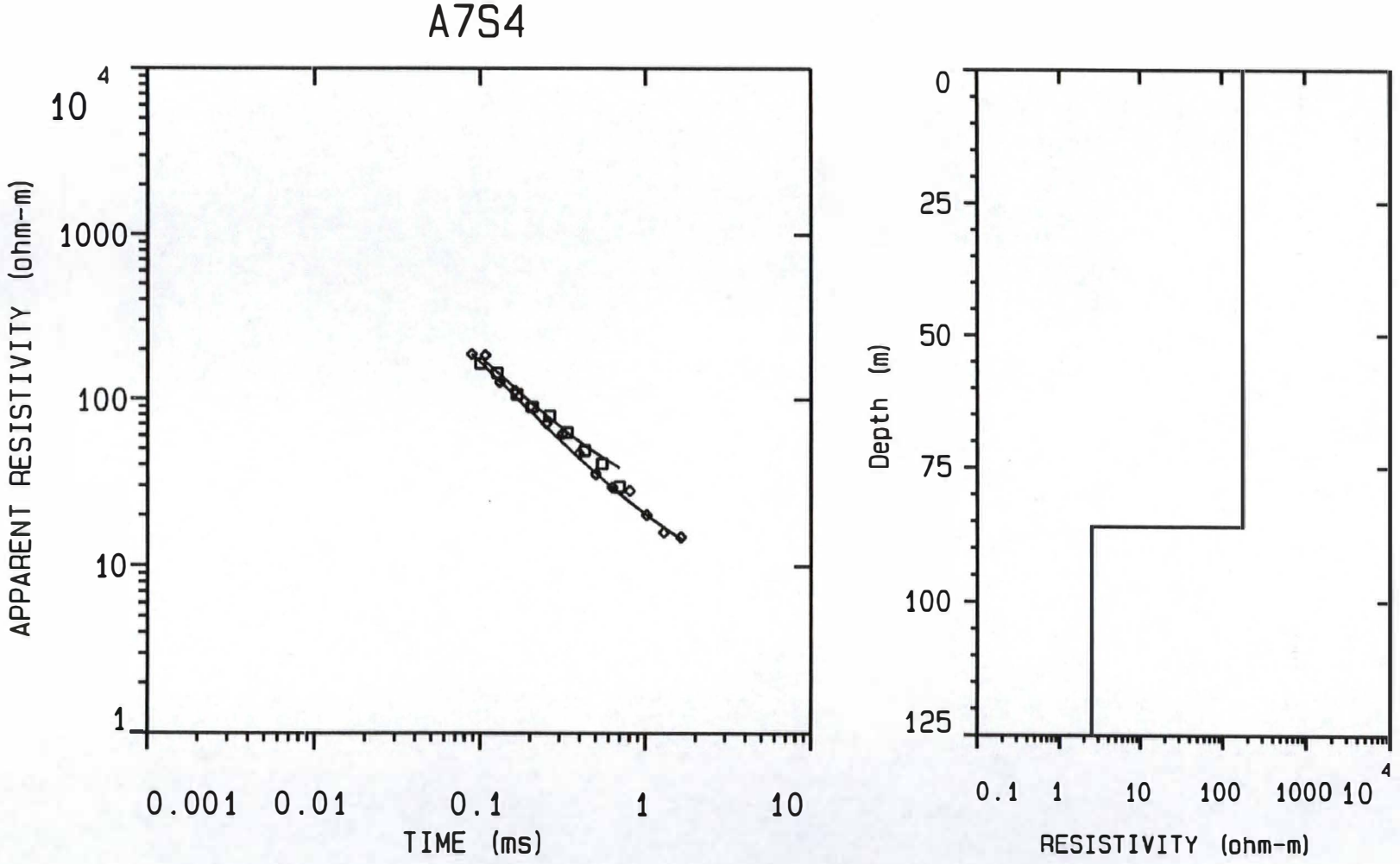
ALL PARAMETERS ARE FREE

CURRENT: 2.40 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 6 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.0881	181.9	177.8	2.24
2	0.106	103.9	107.1	-3.08
3	0.161	72.15	57.20	20.71
4	0.200	47.62	49.06	-3.03
5	0.314	36.81	35.16	4.47
6	0.395	27.62	29.79	-7.85
7	0.499	13.59	25.20	-85.37
8	0.799	17.82	17.82	0.00632
9	1.01	18.38	14.82	19.34
10	1.28	16.32	12.21	25.15

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER
P 1 0.93

```
P 2 -0.21  0.17
T 1 -0.03 -0.10  0.99
       P 1   P 2   T 1
```


A7S4
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
25
50
75
100
125
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A7S4

CLIENT: Lanai Water Company
LOCATION: Manele Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 4.0000 N: 6.0000

DATE: 8-19-01
SOUNDING: 2
ELEVATION: 85.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 14.418 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			85.00	
1	176.9	86.06	-1.06	0.486
2	2.49			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

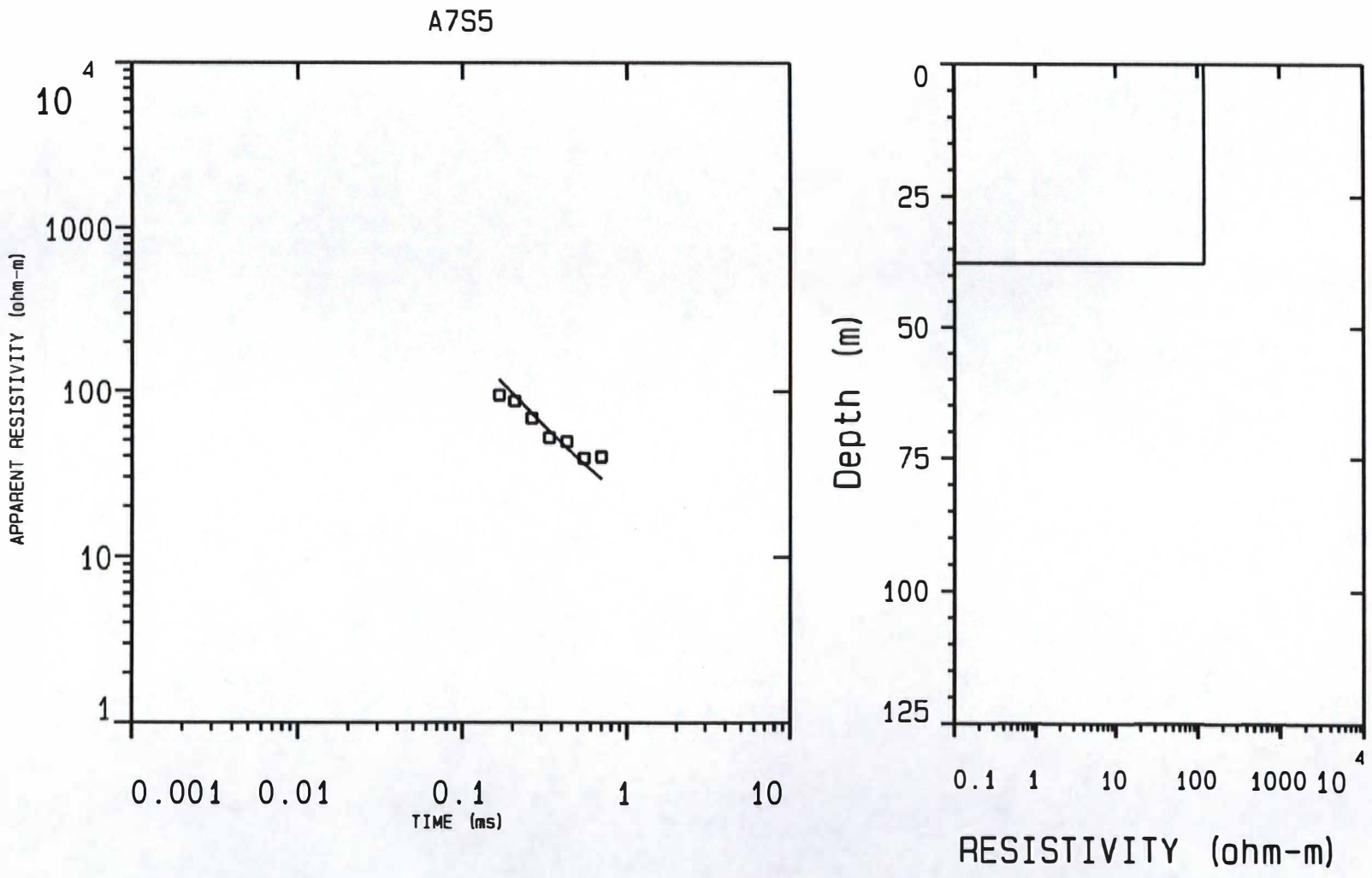
No.	TIME (ms)	emf (nV/m sqrd) DATA	emf (nV/m sqrd) SYNTHETIC	DIFFERENCE (percent)
1	0.0993	139.5	119.9	14.03
2	0.126	91.79	90.90	0.968
3	0.166	73.27	66.39	9.38
4	0.206	55.51	51.68	6.90
5	0.262	36.37	38.40	-5.59
6	0.335	28.16	27.95	0.748
7	0.427	22.18	19.95	10.08
8	0.545	15.81	13.86	12.36
9	0.695	13.88	9.37	32.42

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
10	0.0881	154.1	154.2	-0.0309
11	0.106	96.94	123.7	-27.70
12	0.131	102.2	100.4	1.77
13	0.161	72.50	81.14	-11.91
14	0.200	59.09	65.24	-10.40
15	0.250	48.14	51.89	-7.79
16	0.314	33.70	40.64	-20.58
17	0.395	28.68	31.52	-9.92
18	0.499	24.49	24.02	1.91
19	0.631	17.86	18.06	-1.12
20	0.799	10.68	13.33	-24.80
21	1.01	9.68	9.67	0.135
22	1.28	7.63	6.87	9.88
23	1.63	4.61	4.78	-3.86

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.59		
P 2	-0.15	0.79	
T 1	0.02	0.00	1.00
	P 1	P 2	T 1


A7S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
25
50
75
100
125
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A7S5

CLIENT: Lanai Water Company DATE: 8-19-01
LOCATION: Manele Gulch SOUNDING: 2
COUNTY: Maui ELEVATION: 80.00 m
PROJECT: Lanai EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y) TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 5.0000 N: 6.0000 SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 26.911 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			80.00	
1	118.7	37.65	42.34	0.317
2	0.00241			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 2 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.166	88.25	62.97	28.64
2	0.206	58.64	51.89	11.51
3	0.262	45.52	41.14	9.63
4	0.335	36.99	32.28	12.74
5	0.427	21.89	24.86	-13.56
6	0.545	16.77	18.84	-12.29
7	0.695	8.85	14.00	-58.15

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

P 1	0.06		
P 2	-0.01	0.02	
T 1	0.00	-0.13	0.98
	P 1	P 2	T 1

DATA SET: A7S6

CLIENT: Lanai Water Company
LOCATION: Manele Gulch
COUNTY: Maui
PROJECT: Lanai
LOOP SIZE: 30.000 m by 30.000 m
COIL LOC: 0.000 m (X), 0.000 m (Y)
SOUNDING COORDINATES: E: 6.0000 N: 6.0000

DATE: 8-19-01
SOUNDING: 2
ELEVATION: 90.00 m
EQUIPMENT: Geonics PROTEM
AZIMUTH:
TIME CONSTANT: NONE
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 57.872 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			90.00	
1	94.06	69.00	20.99	0.733
2	0.0607			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 315.00 Hz GAIN: 1 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00681	180423.1	172180.6	4.56
2	0.00869	98001.4	101141.6	-3.20
3	0.0110	76729.3	58657.0	23.55
4	0.0141	39617.7	31648.0	20.11
5	0.0180	14043.8	16756.4	-19.31
6	0.0230	9374.5	8307.9	11.37
7	0.0294	3092.3	3834.2	-23.99
8	0.0375	2914.5	1638.9	43.76
9	0.0479	362.8	665.5	-83.42
10	0.0611	407.6	266.7	34.55
11	0.0779	33.18	118.2	-256.2
12	0.0993	62.29	68.04	-9.23
13	0.126	70.03	45.83	34.55
14	0.166	36.75	34.67	5.66
15	0.206	32.81	27.28	16.85

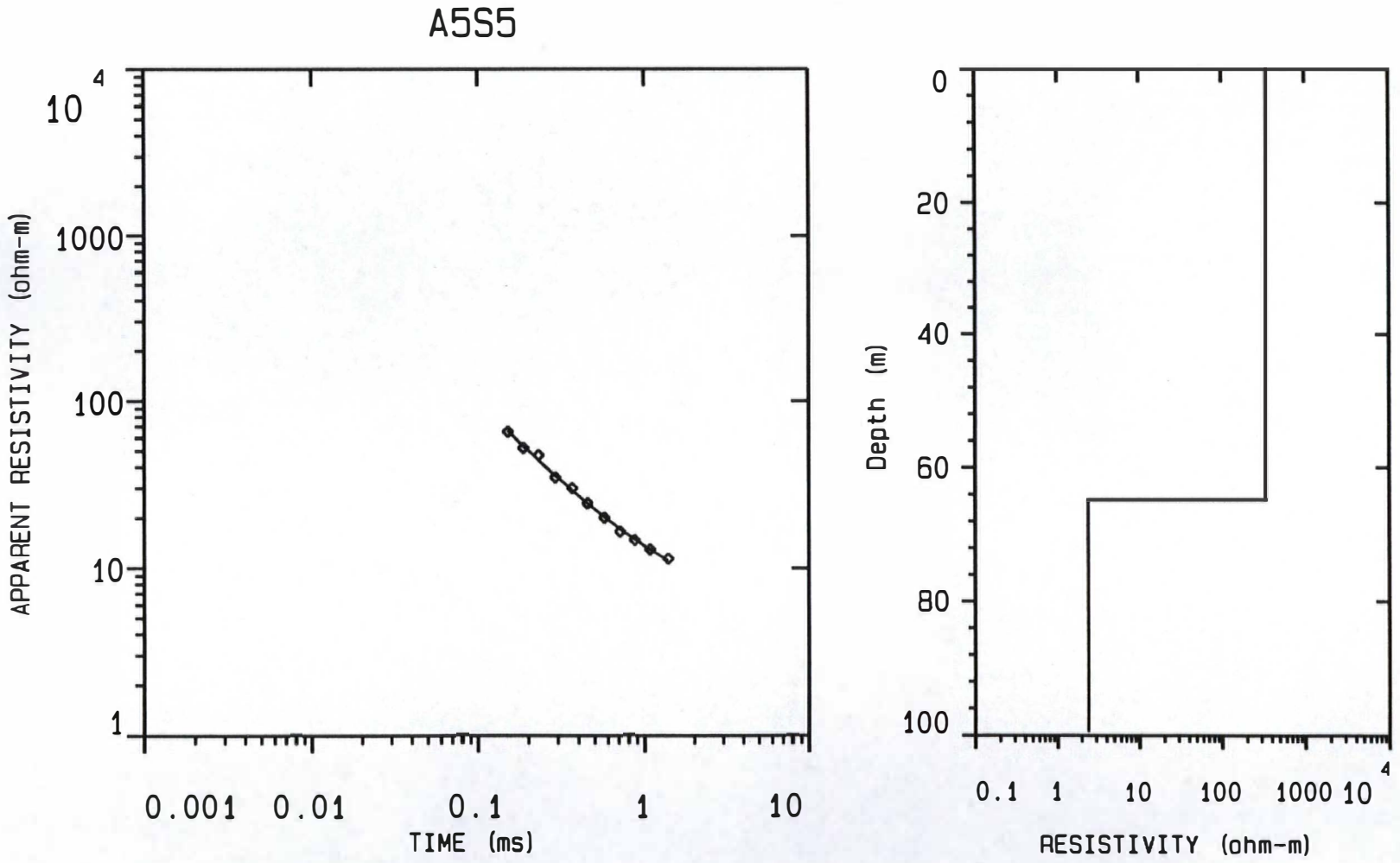
No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
16	0.262	36.93	21.38	42.11
17	0.335	20.48	16.43	19.77
18	0.427	19.19	12.47	34.97
19	0.545	9.73	9.33	4.09
20	0.695	10.02	6.85	31.56

CURRENT: 2.00 AMPS EM-58 COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz GAIN: 7 RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
21	0.0881	174.9	104.3	40.34
22	0.106	115.7	76.29	34.09
23	0.131	111.8	60.20	46.17
24	0.161	46.19	51.55	-11.59
25	0.200	46.07	43.48	5.61
26	0.250	44.86	37.16	17.15
27	0.314	28.73	31.71	-10.35
28	0.395	24.29	26.77	-10.19
29	0.499	18.68	22.65	-21.26
30	0.631	12.42	18.96	-52.61
31	0.799	8.23	15.80	-91.93
32	1.01	6.64	13.02	-96.02
33	1.28	3.43	10.64	-209.6

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER

	P 1	P 2	T 1
P 1	0.99		
P 2	-0.05	0.55	
T 1	-0.01	-0.06	0.99


A5S5
APPARENT RESISTIVITY (ohm-m)
10 4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
Depth (m)
0
20
40
60
80
100
0.1
1
10
100
1000
10 4
RESISTIVITY (ohm-m)

DATA SET: A5S5

CLIENT: Lanai Water Company
DATE: 8018-01
LOCATION: Area 5-Haua Gulch
SOUNDING: 2
COUNTY: Maui
ELEVATION: 50.00 m
PROJECT: Lanai
EQUIPMENT: Geonics PROTEM
LOOP SIZE: 30.000 m by 30.000 m
AZIMUTH:
COIL LOC: 0.000 m (X), 0.000 m (Y)
TIME CONSTANT: NONE
SOUNDING COORDINATES: E: 150.0000 N: 4000.0000
SLOPE: NONE

Central Loop Configuration
Geonics PROTEM System

FITTING ERROR: 4.643 PERCENT

L #	RESISTIVITY (ohm-m)	THICKNESS (meters)	ELEVATION (meters)	CONDUCTANCE (Siemens)
			50.00	
1	343.2	64.80	-14.80	0.188
2	2.42			

ALL PARAMETERS ARE FREE

CURRENT: 2.00 AMPS
EM-47
COIL AREA: 31.40 sq m.
FREQUENCY: 30.00 Hz
GAIN: 6
RAMP TIME: 2.00 muSEC

No.	TIME (ms)	emf (nV/m sqrd) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.151	-193.6	188.7	-2.54
2	0.188	-156.2	150.6	-3.56
3	0.231	-108.2	120.7	11.57
4	0.291	-96.76	93.15	-3.73
5	0.365	-68.39	71.25	4.17
6	0.452	-54.58	54.62	0.0881
7	0.570	-41.20	40.34	-2.09
8	0.712	-31.34	29.71	-5.21
9	0.871	-22.67	22.22	-1.98
10	1.08	-16.09	16.06	-0.136
11	1.39	-10.31	10.77	4.38

PARAMETER RESOLUTION MATRIX:
"F" INDICATES FIXED PARAMETER